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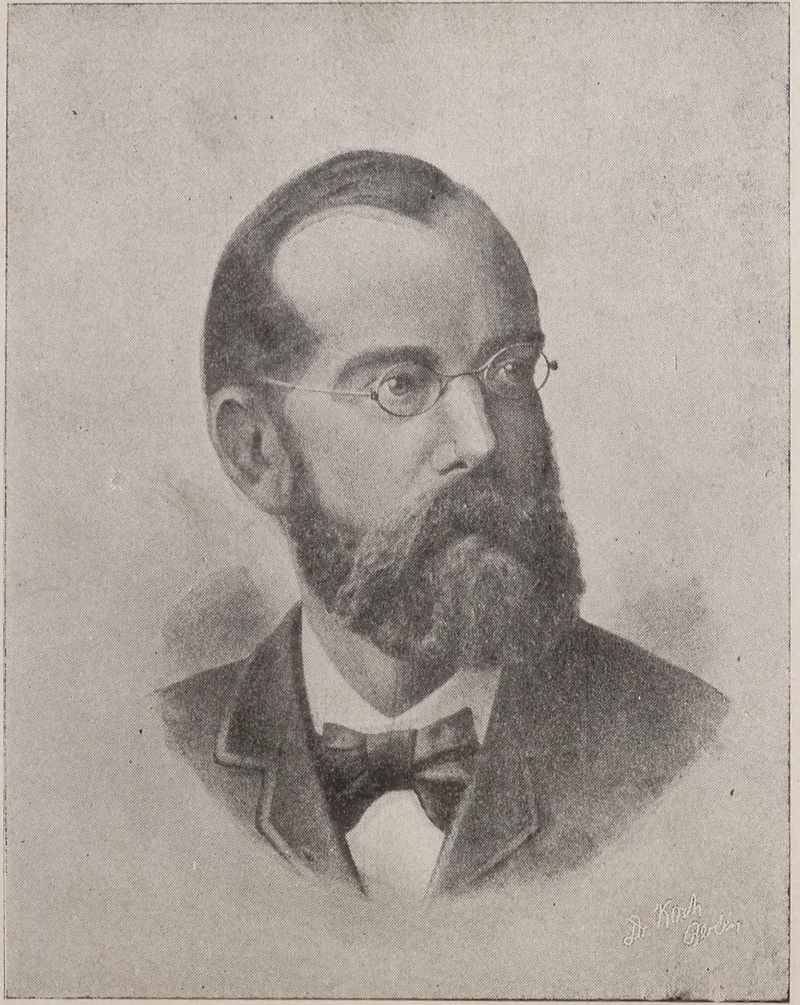
Dr Koch
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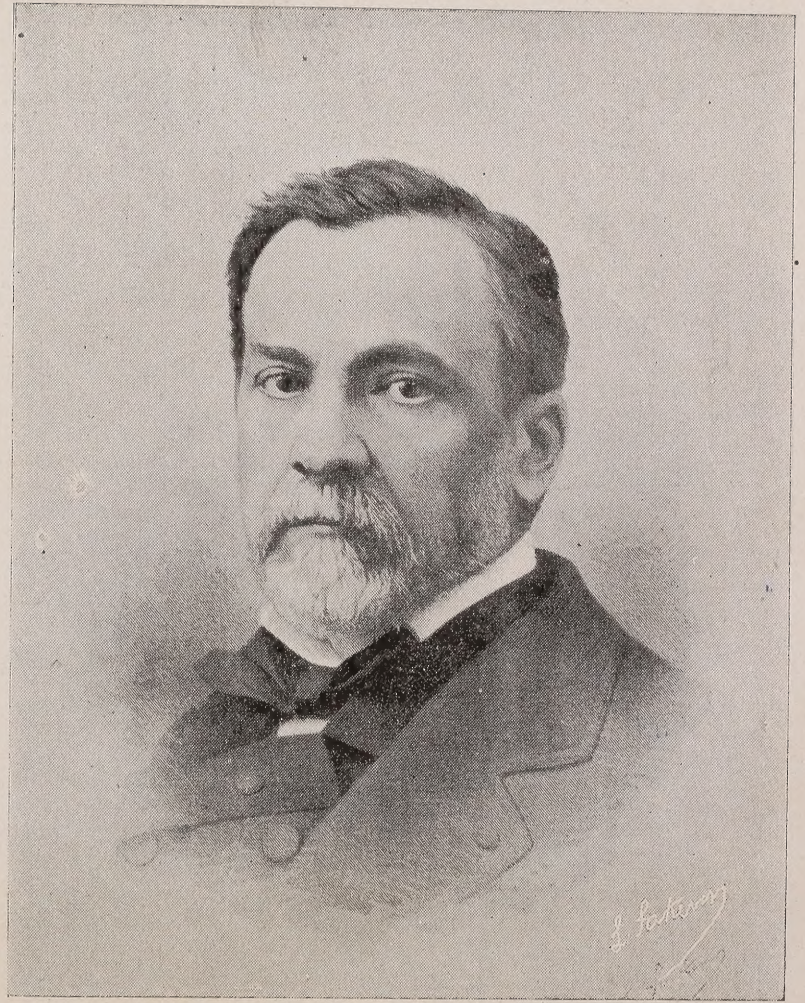
DR. KOCH.



LOUIS PASTEUR.

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THE BACTERIOLOGICAL WORLD

A Monthly Illustrated Magazine Devoted to the Study of Micro-Organisms and Specific Maladies.

Original articles, clinical reports, books for review, exchanges, scientific correspondence, should be addressed to the Editor of the BACTERIOLOGICAL WORLD, Columbia, Missouri.

Subscriptions, advertisements, and all business matters are attended to by Dr. T. J. TURNER, Mexico, Missouri, to whom remittances should be made. However, all moneys sent to the BACTERIOLOGICAL WORLD Co., Columbia, Mo., will be received and promptly acknowledged.

Authors of original articles published in this magazine will be entitled to twenty copies of the number containing it, provided, that they request the same in writing when sending the communication. REPRINTS AT ACTUAL COST.

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Vol. I. COLUMBIA, MO., U. S. A., JANUARY, 1891. No. 1.

EDITORIAL.

With hearty good wishes for a Happy New Year, we humbly present to the medical public our new-born babe the BACTERIOLOGICAL WORLD. It was born, we hope, with sufficient natural vigor to insure its existence, provided that it receives proper nursing from its parents and close friends. But it cannot grow strong, broad, and become a useful and powerful factor unless it receives from the outside a sufficiency of good stimulating substantial food, *i. e.*, scientific and financial aid. Our first plea, then, in behalf of our creature, is for scientific communications and subscriptions.

The BACTERIOLOGICAL WORLD is a new departure in professional and scientific journalism on this continent, and is the child of necessity. Though realizing our shortcomings, we have dared to bring forth this creature because the medical and scientific fraternities, and individuals, on this side of the ocean, feel the need of something of the kind daily, and have waited in vain for years for its birth. Since the discovery of the role of micro-organisms in disease, it has become necessary for the medical and veterinary practitioners to inform themselves on the subject. Indeed, it is now indispensable to know bacteriology as well as anatomy, and to be as well acquainted with the physiology of microbes as the physiology of man. None can understand true pathology as is now clearly demonstrated without at least a fair knowledge of pathogenic bacteriology, and consequently none can practice medicine and surgery as safely, as successfully, as conscientiously and as fairly towards his patients as he who is familiar with the new science. It matters not what unbelievers think of this proposition ; it matters not whether they ridicule the idea or not ; I say with all due respect, that, at this date of the nineteenth century, a medical man, young or old, who refuses to admit the factor of living germs as causative agents in disease is, to his own detriment, far behind the times in medical science, and seemingly shows a disposition to cling to old ideas whether right or wrong. For no man, I dare say, can study the history, life and properties of bacteria, without realizing that there is not more mystery about the parasitic bacteria than there is about the parasitic tapeworm. So far as the existence of the two is concerned we can prove the one more easily because the organism is visible to the naked eye, and the other,—the bacteria,—unfortunately requires to be magnified.

Physicians, veterinarians, students in all branches of medicine are, therefore, in need of knowledge in bacteriology ; and, since it is so new a science, comparatively speaking, they are bound to disappointment, if they desire to advance and depend exclusively on text-books appearing from time to time, for, though these works are all good and necessary, every day brings us something new and important from the various pathological and bacteriological laboratories of the world. Note, for instance, the recent wonderful discovery of Koch !

It is as reporter of everything useful, important and needed in medical bacteriology, that we come to all those interested in the form of this humble magazine, and propose to bring to every home, office and college the discoveries of the investigators of the universe. We offer, in these humble pages, to supply *early* the American continent with every available new point relating to microbes and useful in medicine, that may be brought to light by any of the experimentalists and observers in Germany, Austria, France, Italy, England, America, and all other portions of the scientific world. We propose to bring to the busy practitioner, who can scarcely leave home for special investigations, every new observation, new experiment in specific diseases, etc., and besides, we respectfully offer him an illustrated plain course in bacteriology at a cost incomparably lower than he could possibly obtain it by any other means. All medical men have not the advantage of a second schooling or of laboratory pursuits abroad, but still all are equally in need of the information that is thus obtained by the few. Will they avail themselves of our respectful offer to come to their aid in our humble way through the BACTERIOLOGICAL WORLD ? We have the sanguine hope that they will and thereby sustain and nourish our infant journal. Without the support of the medical fraternities we cannot prosper and perhaps must die ; even the personal sacrifices that we had to make in the shape of financial investment of all our little possessions will be lost unless we meet with a hearty welcome, and the warm sympathy of our friends, and the friends of medical progress and science.

In conclusion, we very respectfully dedicate this : our first issue of 5,000 copies of the BACTERIOLOGICAL WORLD to our many kind friends in the medical profession, and to the friends of science and medicine. MAY THEY FEEL GENEROUSLY DISPOSED TOWARDS OUR NEW–BORN CHILD AND TENDER IT THE MILK OF LIFE—SUBSCRIPTION.

To our new friends in the field of journalism we respectfully bow and ask for a little corner in their glorious and honored field of labor.

KOCH'S TREATMENT OF TUBERCULOSIS.

From all accounts to date, the eminent physicians, who have followed the experimental treatment of tuberculosis by Koch's injection, all agree that it is a success in cases where no serious injury exists in any important organ of the system. If a success, it is without doubt the most beneficial discovery that ever was made in any branch of medicine. Several other glorious discoveries have been made in science which benefited the world in many respects, and among medical discoverers we may point with heartfelt thankfulness to a Harvey, a Jenner, a Pasteur and other luminaries, but none of the past or present can bring such gladness to almost every household in the world—among the rich, the poor, and even the savages, as this man Koch if his lymph proves successful.

Tuberculosis is so widely disseminated, so fatal and so far-reaching in its ill results upon the nations, that a remedy to cure it in its incipiency must be hailed with joy by all men and all nations. Yes, it is a matter of congratulation that science "*n'a pas de patrie*"—that science has no home but the universe at large, so that a useful discovery, be it made in France, Germany, England, Russia, America, or even in "darkest Africa," if clearly given to the world, for the good of humanity, is received with gratitude by all mankind.

The achievement of Koch has something in it which makes a true man's heart feel reverent. His was not an accident, nor was it the result of accidental observations and occurrences, but it was the fruit of medical and bacteriological knowledge applied with accuracy and perseverance, guided by intelligence and honesty, and sustained by a most energetic will power. He discovered the germ of tuberculosis about eight years ago, and in defiance of most determined opposition and most serious objections continued his labors to this moment and with the results known.

We understand that Dr. Koch means to publish the methods by which he prepares his fluid. We expected no less from so great a man, but we fear that a too early explanation of the processes may cause accidents, and perhaps delay the good that must come to all nations if only they will have the patience to wait. In the first place, though a man may be a good, scientific and learned medical practitioner, he may not be versed sufficiently in laboratory technique to prepare this fluid, and the failures, disasters and deaths that might follow impure injections must redound to the injury of the whole new treatment. Indeed, if it takes so much care to produce safe, active bovine vaccine that as yet only few experts succeed satisfactorily, how much more difficult and how much more accurate must be the technique of producing this fluid in a field so new and still so dark as bacteriology? It must be apparent to all medical men, that only comparatively few can safely and successfully produce the delicate material, and no man is justifiable in injecting in his fellow men a substance other than from an absolutely reliable source, *proved to be such* by the character and knowledge of the producer. It seems to us, therefore, that the process should be parted with only after a safe trial at Berlin, and then, too, entrusted first to men capable and fit to carry on the production with absolute correctness.

We sincerely hope, in justice to the famous and honored discoverer, and in justice to the human race, that the excitement, existing now in medical circles and the world over, will not cause a premature exposition of the secret. While most reputable physicians flock to Berlin to witness the treatment for the benefit of humanity, it will be found, as in all other things, that the only aim of some is to turn the discovery into dollars, and they at once would become purely business manufacturers. We find similar concerns now among medicine producers.

It is to be hoped that the wildness now prevailing will soon subside, and that Prof. Koch may thereby find competent men to whom he will demonstrate his methods of procedure, and thus put every mortal within reach of his blessed treatment.

PASTEUR—KOCH.

Our portraits of the celebrities, Louis Pasteur and Robert Koch, will doubtless gratify all who may see them. No two scientists are more popular universally than these two grand geniuses, and no two men living to-day, and perhaps of the past ages, have rendered as great service as they have to medicine and the human race generally.

Pasteur, probably the greatest chemist of the century, discovered and led the way, from a chemist's standpoint, to the wonderful fountain of knowledge in the etiology and prevention of disease, and has since, himself, caused the application of his marvelous discoveries for the benefit of mankind, particularly in his treatment of hydrophobia. Koch, working from a botanical basis, broadened the path, illuminated the darkest passages and led a whole army of investigators through successful excursions and explorations in pathology. His admirable achievements in technical bacteriology, and his great discoveries concerning tuberculosis and other affections, have made for him a name which will outlive the youngest of the present human race. Yea, the names of Pasteur and Koch will live to the end of time, and will be forever cherished by all generations as two of the greatest benefactors that ever blessed the world. These two scientists being the first and foremost bacteriologists, it is eminently appropriate that we should here present their pictures to our readers. Doubtless at this particular time the face of Koch will prove specially interesting, because his recent discovery of a successful treatment for consumption now occupies the minds of the medical men and the masses.

May Pasteur and Koch be spared long years of prosperity, happiness, and of scientific labor, is the sincere wish of the BACTERIOLOGICAL WORLD.

The subscription for the BACTERIOLOGICAL WORLD for one year is $3.00 ; single copies, 30 cents. But we offer here three months' trial subscription (in advance) for 75 cents. Considering the cost of publishing illustrated magazines, this is as low as we can afford until at least we secure 5,000 subscribers. We urge all medical men, of both human and veterinary medicine, and all students interested, to subscribe *at once* if they wish the course in bacteriology complete, for we have issued only 5,000 copies of this first number, have but few left, and cannot afford another edition unless we get a very large demand. Hence, to secure a complete course illustrated on bacteriology (that may be bound at the end of the year), including all the new discoveries that may occur in the meantime, one should subscribe *now*. We may have nothing of this first edition left in a short time and we can afford to print in the future only enough to supply subscribers. Send $3.00 to the BACTERIOLOGICAL WORLD Publishing Company, Columbia, Mo., or to Dr. T. J. Turner, Mexico, Mo. See business announcement with table of contents on the second page of advertisements in the last pages of this issue.

COLLABORATORS AND CONTRIBUTORS.

Among the foremost medical men who have commended and spoken kindly of our enterprise, may be mentioned: Doctors Mitchell Prudden, of New York; Paul Gibier, Pasteur's Institute, New York; J. W. Stickler, of Orange, New Jersey; W. T. Belfield, of Chicago, Ill.; W. C. Vaughan, of Ann Arbor, Mich.; I. N. Love, Editor of the *Medical Mirror*, St. Louis; Professors McAlester and Moss, Medical Department of the Missouri State University. And some of these highly reputed men of science have promised to favor our readers with articles. Their names are a guaranty of the character of the scientific and practical work that they may do for our subscribers.

In the next issue we shall present probably a longer list of honored and trusted names as regular collaborators and contributors. Among them we hope to have specialists in vegetable micology, as we mean to present comparative studies in this department of bacteriology.

LESSONS ON BACTERIOLOGY.

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BY PAUL PAQUIN, M. D., V. M.,
Missouri State University.

PREFACE.

To understand fairly the so-called "germ diseases" it is essential to know to some extent the life history of the microbes in general and of some of them in particular. Unfortunately, most physicians cannot study this satisfactorily because they are so situated, that they must depend mostly on abstract writings for light. There are good books on Bacteriology—indeed some of them are admirable and all have their place and utility, and yet scarcely any one combines in a satisfactory practical manner the natural history of micro-organisms with the technical branches of the new science. From a practicing physician's standpoint, there is, in my judgment, something lacking in these excellent works to make them of as much practical value as they might be in their hands, and to all interested in medicine. Some are very voluminous and so deep as to be useful chiefly to students with leisure, or to experts; others are too exclusively technical. In thinking about the matter it occurred to me that a series of plain lessons on the question of micro-organisms, chiefly from a medical standpoint, would serve a good purpose among many of those desirous of acquiring some practical information on the matter. Accordingly I have concluded to publish such lessons in the BACTERIOLOGICAL WORLD. Practically the same course is taught by the author at the Missouri State University.

In writing these lessons I shall follow the highest authorities.

INTRODUCTION.

The word bacteria, in reference to the so-called "germs of disease," is rather restrictive, because it implies that among micro-organisms, the class known as bacteria is alone capable of causing disease. It is thought now that such is not exactly the case, there are pathogenic micro-organisms that belong seemingly to other classes of beings. The word microbe seems more suitable as a general term.

However that may be it is absolutely proven, that many diseases are due to living forms of the bacteria group. In these maladies the exceedingly minute microscopic beings are parasites, and, generally speaking, some authors think that microparasitic organisms would express better their significance than "disease germs," though there are some very small parasites more highly organized than bacteria.

Bacteria live almost everywhere in the air, water, soil, on and in living bodies, etc., and still comparatively few of them are injurious; these are the microbes which happen to find congenial soil in living tissues and fluids.

The microbic or bacterial diseases then are after all parasitic affections. So far as their etiological classification is concerned, they might be included under the ordinary heading of parasitic maladies though there is a vast difference as to the size and organization of the parasites, for all such agents have properties in common: that is, that whether large or small, visible or invisible with the naked eye, they live at the expense of other organisms and transform portions of the latter's bodies for their own nourishment.

The bacteria have been termed Schizomycetes by Nägeli; they are unicellular organisms, and their mode of digestion and life is such that the transformations which they cause in the nourishing material harboring them is wonderful and great, incomparably greater, indeed, than that of higher organisms.

It becomes necessary then, in order to understand microbic affections, to study the physiological conditions, and somewhat the biological chemistry, of these infinitely little creatures in a general way and compare with that of more complex creatures. These two subjects are in themselves important, deep and long, and consequently, in an abbreviated course, could not be thoroughly treated. But we can and will touch the points essential for a fair knowledge of pathological bacteriology.

BRIEF HISTORICAL NOTE.

The leptothrix of the saliva, and vibriones of the fœces were described by Leuwenhoek over two hundred years ago as animalcules, but it is scarcely more than twenty–five years that the study of "germs" in relation to disease took a decided step in advance. The natural history of micro-organisms had been studied in the interval by Ehrenberg, Dujardin, Robin, Hallier, Cohn and others, but it was not until Pasteur identified the phenomenon of fermentation with the life and growth of microscopic forms that the scientific world opened its eyes as from a dream. In Germany the renowned Koch diligently labored on a botanical basis, and invented accurate methods of bacteria investigation; in England Lister astounded the medical world by his successful applications of Pasteur's discoveries to surgery. The living nature of ferments being known, every country of the globe launched into the new, fascinating field of natural history. And now there is scarcely a civilized nation without some illustrious bacteriologist. But, with all that, our knowledge of the natural history of micro–organisms is still very limited. The bacteria are believed to be vegetables, but the place of some of the finer monads seems yet a mooted question. Generally speaking many micro-organisms apparently lie in the obscure, indefinite border–land between the animal and the vegetable kingdoms. Science may eventually draw a line and place all of them where they belong.

In these lessons I desire to bring forth, among other things, the intimate relations of some microbes with the tissues and fluids of the body, and their actual actions in producing disease with references to plant affections. Therefore, it matters not so much from a practical standpoint to what kingdom the parasites belong, if we can understand their properties, and the results of their existence.

LESSON FIRST.—PART I.

GENERAL IDEA OF FERMENTATION AND LIFE.

Pasteur in his investigations in organic chemistry discovered and proved the living nature of ferments as I have already mentioned. The world was forced to admit that such phenomena as are witnessed in the boiling-like action of the leaven of bread, the fermentation of beer, wine, cider, etc., in the formation of vinegar, are due to the growth of minute organisms in the media in fermentation. Realizing then that the great changes, that occur in such fermentations, really are transformations of certain matter into other substances, he reasoned (after long investigations), that possibly the minute foreign bodies found in certain diseases (such as had been noticed in charbon by Devaine) were also some kind of ferments, and that the changes or lesions found in the tissues, blood, etc., were nothing other than alterations and transformations, a kind of fermentation due to the growth and sustenance of these individuals at the expense of their hosts. This preconceived idea has been amply supported by facts since proven. Parasites of the microbic order are ferments of some kind or other, and their relation to their hosts may be compared with the relation existing between the microscopic vinegar plant and the alcohol which it (the plant) transforms into vinegar; or the relation is the same as that of the putrefaction ferments and the dead bodies that they decompose. In all of these cases there is alteration and transformation more or less complex and more or less complete. The only striking difference is, that germs living at the expense of live tissues, such as septic microbes in a wound, encounter the *natural resistance* of the organized living cells of the body that they have invaded, whilst a ferment in dead matter encounters no resistance from an opposing life.

The parasitic germs (or ferments, or microbes, or bacteria, or schizomycetes if you please) cause disease, therefore, simply because they find in animal bodies (and even in plants) elements that they can transform and utilize for their own nourishment. They break up more or less *living material*, and by that means manage to exist whilst causing thereby very naturally more or less disturbance in the invaded organism. The invasion is resisted in a degree by the constituting (and new cells generated) in the system attacked, and there ensues a fight for supremacy and existence. In this struggle many microbes lose their lives and many body cells perish. If the microbes eventually conquer fully the disease may terminate in death; if the cells (aided perhaps by chemical properties) of the afflicted organism conquer, whether taking medical assistance into account or not, there may be enough vitality left to rebuild the constitution.

It is a sublime sight to watch day by day, with a microscope, certain parasites devouring blood for instance, and to note the reaction of leucocytes and other cells with destructive effects on the microbes. It is a wonderful struggle! A grand battle! The cells of the body are our soldiers, and their defense of the fort against the armies of parasitic germs is admirable and sublime.

Now what constitutes a ferment? What distinguishes a microscopic being of the order of ferments from other organisms in their mode of existence? To grasp the differences and relations, one must bring to the mind a general idea of life. It is essential, indeed, to glance at the processes of nutrition, growth and even generation of organisms of a superior order.

If a seed is sown in a fertile soil—one well fertilized, say with thoroughly decomposed barn manure—it will swell by the action of moisture, give rise to a plant which will grow more or less luxuriously to maturity. Now, how is it possible for that little seed to grow into a plant thousands and perhaps millions of times larger than itself and of a texture totally different in appearance, color, density, etc.? The seed sends forth its first leaves; these leaves by the light fill with chlorophyl, thereby becoming capable of taking carbon, and the new being gradually manufactures living material at the expense of air and mineral substances in the water of the soil. There is a transformation of matter; from *dead* substances *life* is extracted. The plant is a laboratory which utilizes the forces received from solar heat to bring about more or less complex and strange combinations of gaseous or soluble elements of the globe, resulting in tissues and organs as we find them in the scale of vegetable beings. This is the result of their nourishment.

Animals live directly from plants, or from other animals having lived directly or indirectly at the expense of vegetables. So that we may safely say, that the source of life in animals (man included of course) is, after all, the same as that of plants. A being in the animal world springs also from a seed. It is at first nourished at the expense of the mother who gets her food directly or indirectly from plants. The foods of animals are transformed too, and from dead matter serve to make new living matter. But once formed those organized tissues *of plants and animals are soluble no more.* Formed of gaseous or *soluble elements,* there has been erected a wonderful structure that in nature is *proof* against the *action of water.* The fibrous tissues of a tree and its tough bark, the fibrous and muscular tissues of an animal and its tough skin are alike insoluble. And all that, mind again, has come directly or indirectly from elements of the air and water. Suppose then, that the atmosphere and the water did not receive by some means a new supply of these necessary elements for the formation of living organisms, what must be the inevitable result? *Universal failure of life.* The world must get back a supply of the elements used and necessary to form bodies or life cannot be. The air once devoid of these limited organizable elements necessary to form tissues in plants and animals, there can be no more growth or generation of living things. Now what does return these organizable elements to the universe? Ferments! Germs! Microbes!

These invisible mites are indeed the "counterweights necessary" to the existence of large plants and animals. They cause the putrefaction of dead bodies and their transformation into gaseous soluble matter to be utilized by new plants and animals. All that lives must die, and after death the carcasses, the *debris,* are decomposed, fermented, and the air and water are thereby replenished with the organizable elements necessary for the existence of species. So it is that from the *dead* rise the *living,* and that death is necessary to perpetuate the races.

We readily understand, then, that bacterial existence is of absolute necessity, though many microbes happen to cause much injury and disease because they find material fit for their nourishment in other living beings, such as larger plants and animals.

To prove that plant life, and hence animal life, depend largely on the continual transformations of dead matter of the globe into organizable elements, as above explained, it is only necessary to sow seeds in sterilized earth. Such soil being deprived of the fertilization due to microbes, such as nitre etc., etc., barely causes the seeds to sprout; they show a puny yellowish stem, and then perish; or perhaps the seeds themselves perish at the outset of their germination. A sterilized soil cannot nourish plants. This was demonstrated by Duclaux. Whether a maple tree, a man or a microbe, life is in each in a measure dependent on the other two classes; and if one kingdom could be dispensed with it is the animal kingdom. It is plain also, that life in each class can be sustained only by the power that individuals have of transforming matter in various ways for their nourishment.

Now, we must go a step further in this general outline of life, if we would understand the actual processes of transformation in each living thing, including germs.

In the first place, a large plant absorbs from the soil and air soluble matter that it uses, as was before stated, to manufacture its tissues, etc. It finds the food substances already prepared, and only has to make new substances out of them. Generally speaking it does not have first to digest or decompose its food by special secretions. And yet there is a time in a complex plant's existence when such a secretion occurs to prepare food for a special purpose. A sugar beet for instance stores in its roots, during vegetation, a certain amount of sugar which, though constantly in a watery media, never dissolves until the period of flowering. Why does it not dissolve until then? Because the sugar is of the *insoluble kind* in water (stored for the construction of the flower); but then a diastase is secreted by the living tissues of the beet itself—a diastase which has the property of transforming *insoluble* sugar into *soluble* sugar. During this gradual transformation or preparation of sugar the plant appropriates that which it needs to construct the flower. Note the point. A *diastase* is secreted that changes the sugar into a soluble *assimilable* kind.

Now consider a man's digestion. Among many other things that he eats and which are transformed by the various secretions of the digestive apparatus is starch. This substance reaches the intestines and is yet unfit to be assimilated, but the pancreas secretes a *diastase* that transforms the starch into *soluble sugar* which then can serve as food for the economy.

The life of microbes depends on the same thing, but being unicellular organisms instead of complex and highly organized bodies, they do not take in the food and digest it within their own systems. They digest it *outside* if it happens to be proper for their nourishment and unfit for their assimilation. They secrete digestive *diastases* which prepare the food. Thus it is that a piece of flesh is putrefied and even liquefied to some extent by germs to serve as their nourishment. The process of putrefaction is merely a feeding phenomenon.

But, whilst nutrition goes on and diastases of various kinds are secreted to prepare the food, complex living individuals reject also waste materials in the form of gas, liquids and solids. It is only necessary to remember the urinary excretion and the gaseous exhalations of various beings to appreciate this. Well, the same thing is true of microscopic beings, they secrete, excrete. And now these gaseous, liquid and solid materials wrought by the feeding processes of microbes are set free more or less in the universe; they come in contact with the chemical elements of the air and water (and even with each other), and thus chemical combinations bring forth a variety of more or less important products. It is thus that we get vinegar, alcohol, nitre, ammonia, *ptomaines, leucomaines* and various other chemical substances and combinations, either harmless, beneficial or poisonous in various degrees.

Now it may be asked, how can such small beings as bacteria or ferments suffice to the task of transforming all dead matter, etc., etc.? You may form an independent opinion on that point as we progress, but it seems to be chiefly because of their wonderfully rapid propagation, and the property of each to decompose matter so much more in excess of their own weight, than is possible in larger and more highly organized individuals. For example: A seed in germination consumes daily about 2-100 part of the weight of the nourishment within its hull; a dog destroys daily an average of 1-25 of its weight in food; a man about 1-50; fowls about 1-4 of their weight. If we compare that with microscopic beings we find that some of these, like the vinegar plant (mycoderma-aceti) for instance, transform about 100 times their weight. The majority have still far more "destructive energy."

It is perhaps well to give here a preliminary idea of the rapid reproduction of microbes. These organisms reproduce themselves by fission and by formation of spores (seeds). Pasteur in studying the vinegar plant actually saw, from one single cell, such rapid reproduction during two hours (in a poor medium too), that in 24 hours he calculated that more than 16,000,000 individuals had been generated. This is striking but by no means the most rapid reproduction of bacteria. Comparatively speaking this is indeed slow.

At this period in our study, we have already an idea of what are bacteria and of their role in the world. We know now that while acting as *scavengers* they preside at the fertilization of the soil, and prepare therein, and in the air, food to be utilized by plants and by animals; we know that they are useful in arts and sciences in the manufacture of fermented products such as bread, wines, etc.; we know again that some are parasitic and live at the expense of other living organisms, and thereby cause organic changes termed lesions, with accompanying reactions and phenomena which are the symptoms.

A germ disease then is a specific disease, and, I repeat, a parasitic disease, and the symptoms are only the expression of the struggle within between the invading cells and cells of the invaded individual.

PART II.

SPONTANEOUS GENERATION.*

We have had a glimpse of the very interesting role of micro-organisms in the world, and we are brought to face with the question of "spontaneous generation." Whence do these microbes come? Do the minute living cells rise spontaneously in dead matter? Are they born by a "regressive metamorphosis, by a natural transformation of some organic matter"? Could they possibly be generated by any other means than those governed by the normal laws of generation?

In olden times this question was answered in the affirmative by all scientists. No less a great genius than Aristotle attributed the generation of eels to the fermentation of the slime of rivers; and the generation of caterpillars to the putrefaction of earth or plants under the influence of dew. Virgil, in the fable of Aristee, "recounts the birth of a swarm of bees in the entrails of a bull." This may be taken as an indication of the beliefs at the time—beliefs which would seem older than the Christian era, for the Book of Judges in the Old Testament creates bees in the bowels of a lion.

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*The great majority are informed on this question, and to them this portion of my course may seem superfluous; but a few are still in obscurity.

It were a too long analysis to review the history of the eminent supporters of this theory. Suffices it for our object to point to the affirmative belief in spontaneous generation by all naturalists through all ages until this century.

Not very many years ago this view was doubted, and the French Academy of Sciences offered a prize for the solution of the problem. It was solved absolutely and clearly in the *negative* by Pasteur. We know now positively that there is no such occurrence as spontaneous generation of living organisms no matter how little. The smallest ones have been generated by parents. The most minute mass of living individuality had procreators. The era of the microscope has led the way to a clear insight of the dark abyss, and experiments innumerable have, since Pasteur's discovery, verified his assertions.

It is very easy to satisfy one's mind on this point. If a piece of flesh, cooked or otherwise, be exposed, it will putrefy, and perhaps maggots will form in the mass. These two occurrences were once both attributed to spontaneous generation at the expense of the flesh aided by mysterious air influences. But suppose another piece of flesh is heated in a jar, closed only by a plug of cotton, through which the air may penetrate, leaving its germs in the cotton fibers, it will not putrefy, and no life can be found in it. The heat in this case has destroyed life, and the plug of cotton prevents new ingress of organisms. Neither the air nor the meat then have the power to cause the generation of the germs. And all organic substances can be preserved indefinitely by simply killing (by this or other processes) the germs in and on them, and preventing their access to them afterwards.

The germs as all other beings are generated ; we know so little about them because our natural optics are insufficient to see them.

The so-called "germ theory" then, is supported by facts resting on a solid basis everywhere and in every sense. After we realize the unicellular microscopic size of the bacteria, their rapid propagation by normal processes, their ferment properties, we find the question of "disease germs" wholly devoid of the mysterious shroud that surrounds it, in the minds of those ignorant on the subject.

In closing this first lesson I would recapitulate briefly, and fix in your minds a few cardinal points:

First. That the words germ, bacteria, microbe, schizomycetes are used in our present literature almost as synonymous terms, but microbe seems preferable to germ or bacteria, and schizomycetes is a better scientific term than either.

Second. That these are unicellular, and assimilate nourishment, seemingly by absorption in the media in which they live, but,

Third. That they must transform, alter the foods found proper, and yet unfit in nature, for their use and appropriation.

Fourth. That bacteria living on dead matter encounter no living resistance, whilst those feeding on living tissues, or fluids in living tissues, meet the living cells of the body and have to combat them.

Fifth. That the diastases secreted by the various beings, whether highly organized or unicellular and microscopic, have something in common as to their respective objects, and their properties of transforming matter.

Sixth. That the role of microbes in the world is complex and necessary, though some are injurious. They act as scavengers, return to the air and water the organizable elements abstracted daily by the vegetables of the globe, and indirectly by animals, and indispensable to life.

Seventh. That the bacteria, that invade living organisms which happen to be fit for their nourishment and growth, are in a sense parasites just as much as the tapeworm is.

Eighth. That spontaneous generation of living organisms, no matter how little, is a fallacy.

(Our next lesson, in February, will be illustrated in the text. P. P.)

SURGICAL BACTERIOLOGY.

BACTERIAL COMPLICATION OF WOUNDS.

BY A. W. MCALESTER, A. M., M. D.,
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(From investigations of Ogston, Rosenbach, Cornil, Babès and others.)

As the study of pathological micology advances, we realize the nature of many hitherto misunderstood complications of wounds. Until late years we thought the complications in the practice of surgery were scarcely more than two: Septicemia and pyemia, and various affections were classed as ordinary medical cases, which bacteriology has placed definitely among the surgical diseases. Under the heading of surgical affections we now find (from the classification of Cornil and Babes): vesico-pustules of the dorsal region of the fingers; paronychia (felon, whitlow); conglomerated perifolliculitis; furunculus and anthrax (boils); erysipelas; warm abscesses; phlegmons; lymphangitis; thrombus; phlebitis; metritis and puerperal inflammation; pyemia; septicemia; sapremia; arthritis; osteomyelitis; certain forms of endocarditis, myocarditis and nephritis; omphalitis; hemorrhagic septicemia; gangrene; gaseous gangrene; tetanos.

Some of these, such as erysipelas and furunculus, appear often as spontaneous, and many are the physicians who deny their specificity. It is to Ogston and Rosenbach that we owe most of our knowledge on the etiology of these surgical affections. Their deep investigations have thrown a brilliant light on all the complications of wounds of various nature.

Though the bacterial diseases consecutive to wounds have different appearances, and present different specific symptoms, they nevertheless have something in common. They are all characterized by inflammation, and in nearly all there is some form of suppuration more or less pronounced. Several of them may produce the complications known as septicemia, pyemia, gangrene, and several may cause embolism. On the other hand, the biology of the respective causative agents establishes their relation.

The pathogenic microbes, discovered in connection with these diseases, nearly all belong to the class of cocci, which are disposed in chains or masses. The most common are:

First. Staphylococcus aureus, found by Pasteur in furunculus, and existing in the abscesses of pyemia and of osteomyelitis. It was seen also by Cornil and Babes in some cases of ulcerated endocarditis, gangrenous pneumonia, purulent pleurisy, cerebro-spinal meningitis and parenchymatous nephretis. Externally it was found in the air, soil, kitchen water, on the surface of the skin, under the nails, in soiled clothes of healthy children. It is occasionally found associated with the parasites of actinomycosis, tuberculosis, glanders and other maladies. By inoculation it can by itself produce abscesses.

Second. Staphylococcus flavescens, resembles much the preceding, and has much the same properties. It may be distinguished chiefly by the differences in artificial cultures.

Third. Staphylococcus pyogenes albus which has the properties of the preceding, but differs in cultivation.

Fourth. Streptococcus pyogenes. This organism, which appears in the form of chains, presents several species, one of which seems to be the actual cause of erysipelas, and another the cause of warm abscesses, though, as we have said above, other related micro-organisms have been found in such cases also.

Fifth. Streptococcus septicus of pus. It resembles the preceding somewhat in shape, but is much more pathogenic in pure inoculations.

Now there is a microbe described by Passet, that justly belongs here on account of its properties, though it is placed in a group of differently shaped germs. It is the *bacillus pyogenes fœtidus.* A strong odor of putrefaction characterizes its growth.

In many complications of wounds, various other germs may be found associated with these specific pathogenic forms, but they seem accidental visitors. Possibly, too, they work injury in company with the others. It is easy to appreciate the means of ingress in various surgical cases, such as amputations, abdominal operations, obstetrical cases, etc.; but it is difficult to explain the entrance of microbes in such diseases as furunculus and some cases of erysipelas. This point is somewhat theoretical. The appearance of furunculus is usually in regions where the skin is subject to friction, such as the neck by collars, the wrists by cuffs. Lowenberg thinks that the bacteria penetrate by the pilo-sebaceous follicules. Whatever may be their means of ingress, they may be found in the affected parts even though no visible external opening be discovered. Garre has shown, it is written, that the staphylococcus may penetrate even through healthy skin.

The same thing may be said as to the entrance of the parasite of erysipelas, in which sometimes no visible wound is present. Frequently, though, a slight scratch or abrasion had existed and given passage to the organisms, and then healed, leaving no trace.

The local bacterial complications of wounds (such as have been mentioned) may pass off by nature's own efforts or aided by medical or surgical means. They are individually specific in their nature and somewhat independent in their localization, though, as we have seen, related from an etiological standpoint. Microbes of the same order, and with properties very similar, have independent pathogenic powers resulting in the lesions found in each disease locally. But they may be found associated and thus complicating still more a wound, and again, as stated, they may have the company of germs ordinarily harmless, which find in the *diseased* tissues fit soil for their growth and multiplication, thereby aggravating the primary complications.

Pyemia and septicemia are the results of local bacterial complications. At first, there may be only a local abscess, or suppuration of some character or other in a wound; both are the result of germ life. But soon fever appears, there is subdelirium, prostration, and various symptoms indicating general infection or intoxication of the system. It is partly the result of migration of the septic microbes in some important organs, perhaps their generalization in the circulation, and it indicates besides and chiefly the general poisoning by the toxic products generated by them.

The nervous symptoms are conclusive evidences that an impression has been produced by a toxic substance. Such nervous poisoning may be compared as to its origin with alcoholic intoxication—alcohol being the product of a living ferment.

The most important point in the treatment of wounds, therefore, is the prevention of access of micro-organisms. Without them there can be no complication such as has been mentioned here, and hence no pyemia, no septicemia.

There is another form of blood poisoning; it was named *Sapremia* by Duncan, Ogston and Rosenbach. It is that which results from intoxication by products of putrefaction. Occasionally, germs of putrefaction decompose blood or diseased tissues in living individuals, and produce nauseous odors and poisonous substances. Such things occur more frequently in obstetrical cases. It goes without saying that this comparatively rare form of septic poisoning can be avoided as the others mentioned, and by the same means.

Besides the complications that I have mentioned, there are a few others of serious character, that deserve special discussion, but my space is too limited to do them justice. However, I will mention them. As far back as 1856 Virchow and Beckman recognized zooglea in ulcerous endocarditis. More recently Mayer, Klebs, Orth and others gave us a good description of the bacterial, granulous and ulcerous forms of this inflammation.

In their recent and admirable work on bacteria, Cornil and Babes describe pyemic myocarditis, and illustrate the presence of cocci in the muscular tissue of the heart.

In the same work we find descriptions of various bacterial nephretis consecutive to wounds or infectious maladies.

Tetanos is another usually fatal malady now classed among the parasitic kind of bacterial order. The germs are found in the earth, manure and other places, whence they may penetrate through small or large wounds into the system.

But enough for this time, hoping to be able later to treat each malady individually.

HYGIENIC BACTERIOLOGY.

VACCINIA, PATHOGENIC BACTERIA AND VACCINATION.

BY PAUL EVANS,
Pathological Laboratory of the Mo. Agr'l Expt. Station.

Since the discovery of so many pathogenic germs in connection with disease, and their ability to enter the organism through the slightest wound; since we know of the existence of so many kinds of septic germs in water, air, etc., particularly where there is organic matter in decomposition, the medical practitioner often fears to inoculate children or others with vaccinia. The country is flooded with announcements of vaccine propagating farms, and the means at hand for a physician to know the responsibility of propagators, and the purity of their products are in most cases wofully lacking.

On the other hand, on the physician's side, the study of the diagnostic symptoms of true vaccination free from complication has been neglected by many, as has been to some extent even the method of the minor operation known as vaccination.

There is need of improvement until absolute care and cleanliness becomes the rule—such aseptic methods, indeed, on the part of both vaccine propagators and physicians, as will positively exclude all germs except the specific microbe of vaccinia itself. From observations and experience it strikes me that this is not always the case.

GERMS FOUND IN VACCINE.—Dr. Paquin, in studying the germs of vaccinia in virus obtained from three different places in the United States and one in Europe, found in almost every case germs capable of causing complications if they had been in sufficient number, whilst in the virus of one source he found other pathogenic germs than those of vaccinia in great abundance—enough to make it dangerous. In a new operating room with limed walls, Paquin made the following tests, the details of which nearly all came under my observation: *Case I.* Condition of room was apparently clean, no floating particles could be seen with the naked eye but *no disinfection* had been practiced. A heifer about six months old was shaved closely on the abdomen ; the surface of the shaved skin was carefully washed with apparently clean water and soap, and then dried with a clean cloth. Adhering to the surface of this washed skin were found still a few microbes. Ten scarifications were made and each was rubbed with vaccinia. After all the spots had been so inoculated they contained air germs in a much greater quantity than had been found on the skin, these had fallen during the operation and adhered to the raw surfaces. Of course many must have been rubbed in with the vaccinia. The result of this inoculation was that *two* of the ten scarifications developed a diffused inflammation and swelling far more extensive than in a typical pustule of vaccinia. In studying the virus pressed out gently therefrom, it was found to contain less comparatively of the vaccinia cocci, far more serum than in a typical pustule, and a large quantity of the cocci known as *staphylococcus aureus.* These were cultivated artificially and well identified. Only a *very few* of these foreign germs were observed *beneath* the scab of some of the pustules which presented a normal condition, but none in the oozing lymph from them.

Inoculations with cultures of these pyogenic cocci in rabbits produced diffuse local inflammations occasionally followed by suppuration.

A negro boy working in the laboratory was vaccinated on the arm by the writer with virus from such an abnormal pustule, and containing these cocci in a large quantity, and a good pustule was the result, but, besides this, a serious painful inflammation and hard swelling occurred extending to the elbow in one direction and to the shoulder in the other, involving the axillary glands considerably. Cultures made with virus from the pustule of this negro produced unmistakable pus cocci which were inoculable and pathogenic in rabbits.

Now, whilst vaccine apparently pure sometimes causes marked and serious symptoms, it is probable that most of such cases as just described are complications due to the introduction of germs that were on the skin, the lancet, in the air, the water used to wash, or, possibly, in the virus itself.

Case No. 2. The operating room was *disinfected* by burning sulphur bricks during the night with closed doors. In the morning a calf was laid on the table, shaved, washed with soap and ordinary soft water, then thoroughly rinsed with freshly *boiled water*, and the surface wiped with a towel that had been heated 212° F. in a dry oven. The lancet used had been sterilized in a gas blaze, the hands of the operator washed in a bi-chloride of mercury solution 1–2000, and the sleeves were covered from the wrists to the elbows with clean protectors.

Ten scarifications were made and inoculated with neat, clear ivory points from Martin, of Boston. The result was ten typical pustules, free from extraordinary diffuse swelling or inflammation. The virus secreted thereby contained no other pathogenic microbe than vaccinia; pure cultures failed to produce dangerous germs.

Case No. 3 was a case of inoculation in the same condition as No. 2, but ivory points this time *slightly tinged* with blood were used. The result were good pustules secreting pure lymph with vaccinia cocci and no other germs.

My observations, since, of Moss' vaccinations at The Paquin Vaccine Laboratory, where aseptic methods are carefully followed, confirm me in the views expressed here as to the cause of various serious symptoms in vaccination.

I should have mentioned that none of the calves were protected by covering, and that, as a consequence, the surface scabs were in all cases more or less impregnated with external germs, but in lifting the healthy scabs, as stated, and wiping the raw surfaces underneath with a sterilized cloth, these typical pustules secreted *pure virus*, whilst the unhealthy-appearing pustules secreted virus *contaminated*, as explained in case 1.

These incidental studies, though scarcely sufficient and satisfactory, point to the possible danger from impure virus, and to a moral that a conscientious physician should always apply, to-wit: Know the source of your vaccine before applying it. It is not sufficient to know that it is bovine virus, or to know that in a given case this or that virus has given remarkably good results or produced "strikingly good pustules and swelling"; we should know further the nature of the pustule, and the qualification and character of the vaccine producer.

In order to produce safe bovine vaccine (and no other kind should be used), it is evident from the above that several conditions must be fulfilled from an aseptic standpoint. *First,* the stable should be kept scrupulously clean and so built as to allow effective washing of floors, and disinfection of all of its parts and of the air; it should be also perfectly drained and ventilated. *Second,* the calves should be thoroughly examined by a competent veterinarian, and their bodies should be cleaned daily and well brushed. *Third,* the operating room should be so constructed as to be as near air-tight as possible to favor as perfect sterilization of the air and as perfect cleansing and sterilization of the walls, floors, etc., as may be had; such disinfection should be repeated every evening. *Fourth,* the operator's hands and clothes should be free from dust and dirt of any kind. *Fifth,* the water used should be sterilized by boiling; the towels sterilized by dry heat; the lancets sterilized by passing them in a blaze (allowing them to cool afterwards). *Sixth,* inoculate calves only with virus known to be pure. *Seventh,* a vaccinated animal should be protected by some special covering, to prevent contamination of the inoculated spots by excrements, urine and bedding, without interference with the development of the pustules. The bedding should be heavy, clean and constantly renewed. *Eighth,* in collecting the crop, the same aseptic precautions ought to be taken with the operating room, the operator and instruments, as stated already; and the ivory points, receiving and drying vessels, ought all to be free from living germs. In dipping points in such a cleanly room, with hands perfectly clean, the vaccine must be pure if it comes from a good healthy pustule from which kind *only* the virus should be gathered. *Ninth,* physicians, to be on the safe side in vaccinating, should cleanse the skin perfectly with freshly boiled water in preference to any other (never with an antiseptic drug which may kill the vaccine germs afterwards), sterilize their lancet, then make a couple of good scarifications until a slight oozing of blood; after wiping this off with a clean cloth, rub in the virus of a moistened ivory point heavily charged.

Now, if inoculation so practiced, is allowed to be contaminated by the friction of a soiled shirt or drawers, there may be complications yet; therefore, it is well to protect the scarifications with a piece of silk oil cloth applied over them.

The examination of cattle by a veterinarian before vaccination is necessary to exclude all animals showing the least sign of disease, such as tuberculosis for instance, which is so common in cattle and communicable to man.

These bacterial complications of vaccination may explain some failures in vaccination of people, and of calves used for the production of vaccinia. For instance, germs producing much serosity in the pustule may cause death of the vaccinia cocci by virtue of the bactericide property of serum. Again, the possible antagonism between the bovine vaccine microbes and other germs in a pustule may result in weakening or destroying the virulence or life of the former. The writer has known vaccinia sent 1,000 miles to the south in the warm portion of summer, tried by physicians without success, returned after three weeks or more, then tried on calves to take perfectly. May we not conclude that in some such occurrences the vaccinator inoculated in the arm or leg, or allowed to penetrate various air germs antagonistic to vaccinia, and that the latter suffered thereby? How often are not unclean arms scratched, inoculated and then covered with a soiled raiment?

THEORY OF INFECTIOUS DISEASES, CURE, VACCINATION AND NATURAL IMMUNITY.

(Report by Chas. Bouchard to the Academy of Sciences, Paris, France.)

I can deduct from the experiments made, that I have already communicated to the Academy, the conclusions which constitute a new systemization of infection and immunity.

If the infectious agent inoculated falls into an animal organism which is a medium very bactericide, it does not develop itself; it does not outlive the disease; if the living animal constitutes a media very favorable, the microbe develops itself immediately; if the media is moderately bactericide, there is in the life of the microbe a first phase of degeneration;

during a short enough time (a few quarters of an hour) its multiplication is suspended; but it lives meanwhile, and, through its diastase, adapts to its needs the material of the tissue where it has been deposited; then its interrupted development disappears.

When the development of the pathogenic agent was immediate where it had been preceded by a phase of degeneration, the malady commences. In time they multiply themselves, the microbes secrete chemical substances in larger and larger quantities, some of which act on the nervous system, causing the change of the circulation or of the modification, nervous headache, delirium, coma, convulsions, etc.; all the others impressing all the cells of the body, changing their nutritive type, and, by their intermediate agent, modifying the chemical composition of the humors which can thus become bactericides. This last effect is tardy, but it is durable. The poisonous substances which impress the nervous system have a more rapid action, but more temporary. Among these rapid and transitory actions is the paralysis of the vaso-dilatator nervous centers, which renders impossible the exit of the white globules outside of the vessels.

When the number of the microbes becomes such that their products of secretion constitute a mass which can no longer be ignored, the febrile and poisoning symptoms appear. The bactericide state does not exist yet; the phagocytism alone could save the menaced organism; but the phagocytism is rendered impossible, because, while secreting the other poisonous substances, the microbe has secreted the material which prevents diapedesis. Thus in a media which is still chemically favorable to its development, and protected against the most important of the cellular reactions, the microbe continues to multiply and secrete freely, the intoxication augments, the malady grows worse; death may supervene in this period.

But, during this time, the materials which change the nutrition of the cells were secreted also, but their slow action does not manifest itself yet. In a moment they have impressed the cells enough in order that their nutritive type be modified, in order that the humors be, in consequence, changed chemically. The bactericide state is a possible effect of this chemical change. It appears slowly, but as soon as it appears the life of the microbes is impressed, their pullulation slackens or arrests itself, their secretions suspend themselves. The material which opposes the diapedesis, in particular, comes no more to paralyze the vaso-dilatator nervous center. Then the white globules come out of the vessels, and the phagocytism destroys at last the microbes already attenuated by the bactericide state. This is the cure.

The cure is the first manifestation of the acquired immunity. The bactericide state, produced slowly by the passing impregnation of the cells in contact with vaccine substances, persists a long time after the elimination of these materials. If, in a vaccinated individual, this bactericide state is very pronounced, the microbe which produced the first sickness, introduced by a new inoculation, cannot vegetate ; there will be neither a general infection nor a local infection ; the immunity is absolute. If the bactericide state is less pronounced, it does not prevent the life of the microbe, but it attenuates it, it diminishes the activity of its secretions ; one of these, in particular, becomes incapable of paralyzing, as formerly, the vaso-dilatator center ; the diapedesis is not prevented, and the phagocytism arrests and terminates the infection in its primitive point. The local lesion has been rendered possible and it has prevented the general infection from presenting itself.

The natural immunity does not depend on the bactericide state ; it results in a greater resistance than, in certain species of animals, the vaso-dilatator center opposes to the material with paralyzing properties. The proof is that the diapedesis, normally provoked in these animals by certain microbes, pathogenic in other species, does not occur if we inject with the dose of virus to which they resist, a stronger dose of the chemical substance which prevents diapedesis. We notice, then, that the diapedesis and, consequently, the phagocytism do not take place ; we notice further that general infection produces itself.

ORIGINAL ARTICLES.

ACTINOMYCOSIS.

(By the Editor.)

This is a specific disease of much interest in the United States to-day. It exists among cattle, in the West at least, to an alarming extent—our live-stock markets witnessing hundreds of cases monthly. I have seen personally a good number of cases in official capacity, and all the members of the veterinary sanitary force of the State of Missouri have had more or less extensive experience with it. In view of the possible transmissibility to man, it has become a question of national importance, and one which has been too long neglected by sanitarians.

The question, involving as it does such a vast industry as cattle raising and beef production, is one in which various interested parties seem to interpret to suit their respective cases without regard to facts and the general good. Indeed, conflicting opinions have been given by several reputable veterinarians and physicians seemingly without regard to the most recent investigations and discoveries. From various parts of the country have arisen defenders of this and that interest, in Illinois for instance, when state and city authorities and the stock-owners conflicted this year. If all those who ventured opinions on the subject would have searched the history of the malady fully, its pathology, causation, dissemination, and the most accurate of the old as well as of the new investigations, experiments and discoveries, they must have come to the unanimous verdict which some of them, in the cases alluded to, have wisely reached, *i. e.*, that actinomycosis is a *specific, parasitic* and, therefore, *transmissible* affection. Whether directly or indirectly transmitted is not the all-important point, but the fact that it is at all transmissible in any way is the interesting feature. And when we consider that actinomycosis in man and beast is identical, we have still a far more interesting subject.

The writer is at present carrying on experiments in connection with this disease, and is not prepared just now to speak fully on all points pertaining to its pathology and its parasite from a personal investigation, but he will treat the disease as fully as possible in these pages under the circumstances, and cite authorities at his command.

This writing is merely from a medico-scientific standpoint, and not in any sense meant to enter into discussion with any of the medical men who may have expressed different views.

ETIOLOGY AND HISTORY.—Actinomycosis is due to a vegetable parasite growing in tissue thereby causing chronic inflammations of various degrees; it was named "actinomyces bovis" by Bollinger, in 1877 (Germany), after the results of Harz's investigations made under the former's direction. The name was given because of its radiated form (*aktin*, ray, and *mukos*, mucous) at that time its filaments had not been discovered, or had been misinterpreted. These little vegetables appear grouped in yellowish granules. But years before that Langenbeck (Germany) and then Lebert (France) had given the first anatomo-pathological observations of the affection in man. Robin (France), in 1871, observed identical lesions and parasites and misunderstood their nature. This is as far as the study was carried in man until after the disease was well described in cattle.

In the meantime Sebastiano Rivolta (Italy) found the actinomycosis granules in studying sarcoma of cattle, but attached no significance to them until 1878, when he again investigated new cases and became convinced of their parasitic nature. In 1875, Perroncito (Italy) studied osteo-sarcoma of cattle and wrote the nature of the actinomyces, coming to the conclusion that it was a cryptogam.

These investigations stimulated others, and again the study of the disease in mankind was undertaken. Israel (Germany) described three cases in man. Ponfick, in 1879, identified the similarity of actinomycosis of man and cattle. And since then Europe has reported over fifty cases in human beings, whilst a dozen or so are recorded here and there in America as having been identified. Having so much of it in cattle, I think that some cases of actinomycosis in man, like cases of glanders, are not recognized; I knew of one case in Southern Missouri which local physicians diagnosed by various names. The man had probably contracted the disease from an ox which was suffering from actinomycosis at the lower maxillary; the ox and the man had the habit of drinking from the same trough. The lesions in the man were in one of the maxillary articulations.

Authorities state that in man the disease is always characterized by two appreciable things: Abscesses and yellowish granules in the pus of the abscesses. In cattle it is not always so. The parasites growing in the muscular tissue of the tongue for instance cause this organ to become as hard as wood, and it is free from pus. However, pus cavities of various sizes are the most common lesions in cattle also, and in them the yellow granules as seen in man are always found though sometimes with difficulty.

LESIONS.—I do not intend to describe the pathological anatomy fully in this article, but will refer briefly to the most striking diagnostic points in man and beast—intending to cover the ground more completely later if possible, when our investigations are completed. In man actinomycosis develops ordinarily about the maxillary articulation, in the neck, though it has occurred in the liver, lungs, stomach and certain glands. In external parts the pus generates and localizes in a flat, diffuse manner unlike the prominent tumor in cattle. If palped the whole mass of pus seems to move in one piece. Slowly the skin softens, becomes reddish, perforates, pus exudes, and in it may be found the characteristic, yellowish granules. Whilst this ulcerative process goes on towards the exterior, it also penetrates deeply attacking all the tissues in the way, such as muscle, ligament, periosteum, bone, etc.

Cornil (France) and Babes (Roumania) describe six forms of actinomycosis in man:

First. The cervical-maxillary just mentioned.

Second. The limited neoplasic form, affecting the parotid region.

Third. The thoracic form, affecting the lungs, pleura and bronchial tubes.

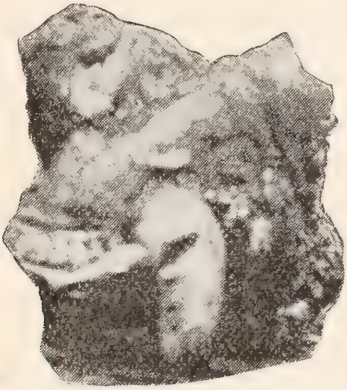
Fourth. The lombo-abdominal form, in which the disease is in the soft tissues of the abdomen and bones of the lumbar region.

Fifth. The pyemic form, in which a number of abscesses are disseminated in various organs.

Sixth. The peritoneal form, in which the lesions are localized in the peritoneum, sometimes causing perforations of the intestines. Ulcers of the intestines were observed.

Virchow in one autopsy found lesions in the thigh and knee.

Among animals actinomycosis occurs usually only in cattle, in which it is known as big jaw, lumpy jaw, etc. Two or three cases only are on record as having occurred in the horse and in the hog.



(Tumor of actinomycosis on maxillary of cow.)

The lesions in cattle vary greatly according to the organs and tissues affected. It usually appears at the lower maxillary, but is by no means confined there ; it occurs in most of the organs. The parasites may cause the production of a fibrous tissue, sarcomatous tissue, soft sarcomatous embryonic tissue, and sometimes there is even calcification. The specific nature of actinomycosis is recognized in those tumors in the form of yellowish, grayish and sometimes reddish bodies or tubercles ranging in size from a small pinhead to a walnut. The specific yellow actinomyces granules or masses are located in these bodies.

The intestinal tissue and the peritoneum frequently present numerous nodules of various sizes (many about that of a small pea), containing the actinomyces. In the liver such tubercles are frequent, and even abscesses are occasionally present. In the lungs occur often large abscesses and numerous tubercles and nodules in which the actinomyces are again found. Some affected lungs present the aspect of a case of tuberculosis and its consequent inflammation, but as distinguishing lesions it will be remembered that actinomyces never causes the coagulation necrosis or caseous degeneration characteristic of tuberculosis. Still, the two affections have been noticed in the same individual.

Another characteristic symptom in actinomycosis is the tendency of the abscesses to perforate the skin ; it is so in man and beast.

Judging from the various *post mortem* examinations which I have witnessed, it seems to me that the various forms described in man by Cornil and Babes might be applied justly to animals. In 42 *post mortem* examinations in cases of actinomycosis at which I was present (34 of which were made under the supervision of the Illinois State Board of Live-Stock Commissioners at Chicago, August 18, '90), the actinomycosis lesions were found distributed as follows : In the lungs in 6 cases ; tongue, 5 cases ; liver, 11 cases ; intestines, 19 cases ; post-pharyngial, 7 cases ; maxillaries, 35 cases. It will be understood, of course, that several had many organs affected. In some, the inferior maxillaries, lungs, liver and bowels were diseased, and in others only a local external lesion with or without suppuration.

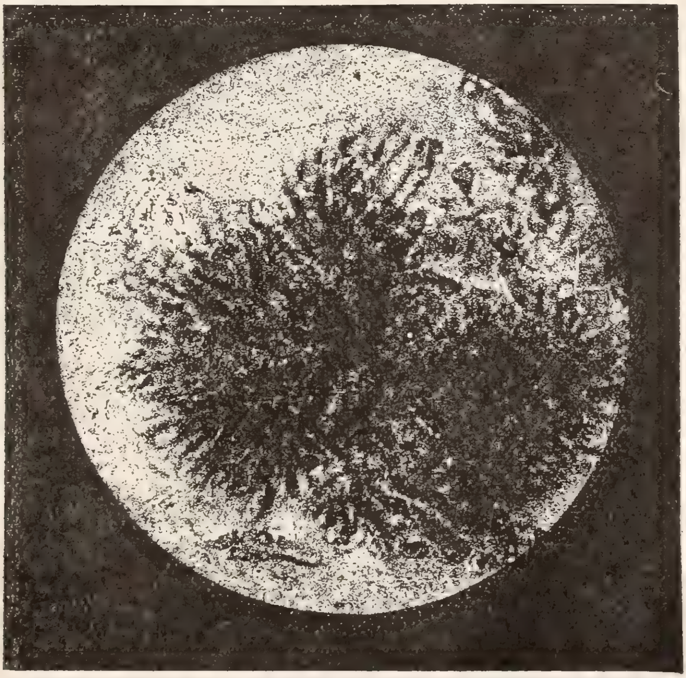
Processes of infection.—It seems that all the authors agree on the mode of infection in man and beast, *i. e.*, by lesions communicating with the exterior. These lesions may not be accessible to man's eye such as in the intestinal tract, the lungs, but they are no less openings to parasites. Ponfick and others have mentioned decayed teeth in man as a point of entrance of the actinomyces ; he has also mentioned, in that connection, a wound of the thumb. Majocchi records a lesion in the skin as having given ingress to the vegetable. Canali and others speak of bronchial wounds in the same relation. Cornil and Babes state that it is probable that the introduction of the parasites occur by absorption by the lymphatics of the mouth (without any abrasion).

In cattle we may safely say that the same means of introduction cause the infection. We know, in fact, that most of cases show lesions about the teeth. At first, perhaps only a little nodule may be perceptible at a point on one of the maxillaries, but gradually it enlarges, then it softens, opens outside, a fistula is formed, and one may sometimes pass a probe through to the inside of the mouth—the corresponding tooth or teeth having been destroyed more or less. In such cases the parasites probably gain entrance between the teeth.

As in man, then, it is rational to believe that any abrasion may give entrance to the vegetable.

Babes mentions a form of actinomycosis in cattle which he terms "myelogenous actinomycosis"; it localizes in the vertebral column in the interior of the bones in the form of purulent tumors with fistula. Perroncito describes another kind which he found localized in the skin and subcutaneous tissue in the form of sarcomatous and fibrous tumors. Finally, Rivolta and Johne saw the actinomyces, in the chronic inflammation of the spermatic cords of a horse resulting from castration.

THE PARASITE.—Until recently the actinomyces was supposed to be a fungus; but Baumgarten, Podwissowsky, Affanassiew, Cornil and Babes, who have studied its biology more deeply and a comparatively short time ago, place it among the cladothricea; hence it would come in the domain of bacterial studies.



(Unstained microscopic view of actinomyces after Cornil and Babès.)

Artificial cultivation has been generally unsuccessful. Yet Johne seems to have succeeded on blood serum, Israel in Pasteur's broth, Bostrom on gelatine.

INOCULATION of actinomycosis is possible ; the authors just named, and Budjwid (*Sankt Petersburger Medecin Wachenschrift,* 1888), have succeeded several times. Johne has transmitted the disease from cattle to cattle by inoculation through the skin and obtained local lesions after two months. Ponfick succeeded in inoculating it three times through the skin and in the peritoneum. Israel inoculated a rabbit successfully once through the peritoneum with actinomyces *from a man.*

COMPLICATIONS.—In the abscesses, several authors and the writer have found, besides the actinomyces, the streptococcus of pus. It is possible, then, that various pus germs complicate actinomycosis, and, perhaps, the formation of large abscesses depends on the aid of these microbes in destroying the tissues gradually altered by the former.

SANITARY QUESTION.—This disease being *unquestionably* parasitic and *unquestionably* transmissible, it interests the public to know what disposition should be made of stock so affected. In the first place the diseased stock should be destroyed and burned on the farm by the owner as soon as discovered. This is the safest means of eradicating the disease at home so far as known now, for the life history of the parasite outside of living organisms is yet a mystery ; it is, therefore, impossible to prescribe rational modes of prevention such as disinfection, etc., in fields, stables, and the like, particularly before the disease makes its appearance. A building contaminated with pus may of course be cleansed in the usual ways.

It is useless in the majority of cases to attempt *treatment* of the local lesions. True the tumors of the jaw may be excised, the wounds cauterized and a local cure may follow. It is even possible sometimes to arrest the growth of such a tumor by iodine and bi-chloride of mercury injections. But who knows that the parasites are not already located in some inaccessible organs of the body, such as the liver, the intestines, etc.? Should any such chances be taken ? No ; the owner is safer in slaughtering at once a case of actinomycosis, and the people are thereby saved from grave dangers.

At stock-yards and slaughterhouses the plea is sometimes made by owners that a blow or a local injury of some sort is the cause of a jaw tumor that may be visible. This should be accepted only with the greatest circumspection ; for such accidental and sudden swellings of the bone are extremely rare in cattle to say the least.

It has been claimed by interested parties and even by physicians and veterinarians that the flesh from many animals suffering from actinomycosis is harmless. That may be true in part, and again it may not be true in any sense ; it depends on the actual distribution of the germs. If the parasite is such that it can reach the liver, lodge in the peritoneum, invade the muscular fibers of the tongue, cause abscesses in the bones of the vertebral column, who will say that the rest of the body and the flesh is surely free and safe ? True the muscles with the exception of the tongue do not frequently present visible lesions, but still they do occasionally, and if the germs migrate here and there in the body through the circulation what portion can be presented to the meat consumer as perfectly safe and healthful ? It cannot be safe, and competent rigid inspection of stock before killing, and of the carcasses immediately after killing are the only safe means of preventing such meat from reaching man's stomach.

The diagnosis of actinomycosis in cattle is easy enough if local lesions are present ; there can be no doubt when abscesses are formed and pus can be obtained for naked eye and microscope examination. In man diagnosis may be more difficult, but here also it is possible, in many cases, to obtain the specific pus showing the actinomyces ; this is the more easy if an abscess is external, though it is also possible very frequently to make a positive diagnosis of lung cases by examining the sputa microscopically. Among the pus may be seen without a microscope the fine, more or less spherical, yellow granules which contain the parasite and they may also be felt with the fingers. If they are masked by the pus mix a little of a potash solution with it to destroy the cells and the actinomyces granules may then be seen. If still they are invisible, then a microscope must be used.

The technique of the microscopical investigation is too long for this article, which, on the other hand, was not intended to treat of the histological and microscopical processes of investigation.

In conclusion, I beg to say that the State of Missouri recognizes the specific, transmissible character of actinomycosis. The Veterinary Sanitary Officers have not stopped at the objections raised by many that the disease is not contagious. In our present knowledge of specific diseases the word contagious means only *one* form of transmission, and, if a disease can reproduce itself by *any means* in susceptible individuals among our food-supplying animals and mankind, it is sufficient to stamp it as dangerous to public good and public health.

NOTE :—After writing the above, the author came across the following, which appeared in the *Journal of the Royal Microscopical Society of England,* and which emphasizes the foregoing. This is a criticism on part of a report by Prof. Crookshank on Anthrax, Tuberculosis and Actinomycosis :

"The third disease, actinomycosis, is discussed at considerable length, but at the same time with perspicuity, and these four papers form together the best *resume* of the subject in the English language we have seen. This fungus disease, which has been found to attack almost every part of the body, was first brought into notice by Bollinger in 1876. The first cases were discovered in oxen, but a few years afterwards the same disease was found in man. The microscopical appearances vary with the anatomical distribution, and also with the rapidity of the disease. The microscopical appearances of the fungus are of two kinds, club-shaped elements which tend to arrange themselves in rosettes, and delicate filaments. The club-shaped elements, which were the first to be recognized, easily stain a red color, while the filaments, which were only discovered comparatively recently, stain blue. It is owing to this staining difference that Prof. Crookshank was able to demonstrate the intimate connection between the two ; for, by making careful preparations, he has shown that the filaments spring out of the clubs, and that 'the structure of a rosette consists centrally of a dense mycelial network, and externally of a hymenium of basidia.'

"The question of transmissibility from man to lower animals is easily answered in the positive, for calves and rabbits have been successfully inoculated with the fungus.

"By the aid of the microscope, the author was able to show that 'wens' or 'clyers' are only local manifestations of the disease; previously they were regarded as the result of a strumous or tubercular diathesis."

PRINCIPLES OF ANTI-RABIC VACCINATION.

BY PAUL GIBIER, M. D.,
Director of the New York Pasteur Institute.

To treat of the principle of the vaccination of an infectious disease whatsoever is, in using a particular example, to deal with the question of immunity in general. If, according to a theory, which I am not perhaps the first to have emitted, the multiple causes of acquired immunity all rest finally on a unique principle, we must acknowledge that in certain zymotic diseases, such or other of the causes of the acquired immunity will have more or less the advantage of the others according to the case.

Concerning rabies, if we examine different experiments which have been attempted to explain the mechanism of immunity, we see that science is very far from being fixed on this point. We will analyze and discuss as briefly as possible a few of the researches which have been undertaken on this subject.

Let us glance in the first place to the fact itself. Let us take a dog and introduce beneath its skin a certain quantity of rabic virus. This simple fact may have four different issues. The dog may die after a variable time or it may survive. 1st, when it succumbs it is of rabies, or, 2nd, it is from the intoxication by the rabic substance without being rabid. If it survives it may, 3rd, be not vaccinated, or, 4th, have acquired immunity by the fact of the injection. We may summarize this first exposition in the following table :

Inoculation
- A. Death
  - 1st. By hydrophobia.
  - 2nd. By intoxication.
- B. Survival
  - 3rd. Without immunity
  - 4th. With immunity.

Let us examine now the circumstances in which the cases above mentioned may be produced, and let us try and understand the mechanism thereof. Though the question be, from an experimental standpoint, relatively recent, the enthusiasm for the experimental method has developed itself so much in the last years, that the number of researches which have been made on this particular point is already considerable. It is, consequently, necessary to have recourse to a classification somewhat artificial. Let us, therefore, proceed in order.

1st. *After the injection the animal dies of rabies ;* it presents characteristic symptoms of the disease before dying, and after death the virulent principle may be found within in its bulb. In this case it is very probable that the needle, if it has not extended beyond the limits of the cellular tissue, has wounded a nervous filament, and that the virus was put in direct contact with the elements of the nervous fiber. The experiments of Pasteur, Roux, Bardach, Helman, etc., and mine prove that the virulent element of rabies has a particular choice for the nervous tissues. Helman, of St. Petersburg, has demonstrated in his experiments, that if the anti-rabic injection may be inoffensive when it is made in cellular tissue it almost invariably causes death if the needle wounds the muscle beneath, or if intentionally the injection is pushed in the muscular fibers. It is likely that it is because of the great quantity of terminal nervous *plaques* associated with muscular fibers that infection takes place ; it is equally for the same reason that the superficial erosions of the skin which expose a large number of terminal sensitive nerves are so frequently followed by rabies in cases of bites apparently most benign. Let us say finally, that it is principally when the quantity of virus is light that inoculation has fatal results. When we shall come to the study of the case in which immunity is produced, we will see, on the contrary, this apparently paradoxal fact, that the injection of a large quantity of virus may be completely harmless.

2nd. *Following the injection the animal dies intoxicated.* In order that death be produced in this case it is understood that a more or less considerable quantity of rabic substance must be inoculated. It is not even necessary that the inoculated substance be still virulent. Babes and Lepp of Bucarest, Roumania, have made experiments in which the injection of strong doses of cerebral substance of rabid rabbits, sterilized by heat or filtered through porcelain, has determined death after a few days. The dogs which received that injection died with symptoms of general weakening without symptoms of rabies, and the intra-arachnoidian inoculation of their bulb remained without action on animals on which it was practiced. The filtered alcoholic extracts of rabid brains, evaporated in vacuum and giving ptomaine reaction, produces in rabbits, guinea pigs and mice, after a few days, death without paralysis and without symptoms of rabies. The extract of brains of animals of the same species, but in good health, inoculated in the same conditions produces no accident. This intoxication is obtained with much more difficulty if by small doses gradually augmented the organism is accustomed to it.

3rd. *The animal survives and has no acquired immunity.* I will not insist on this point; it will be easily understood that a single light injection is insufficient to determine immunity. There is reason to ask how it happens that this injection which does not produce immunity does not cause death. We will try and explain this fact in the following paragraph, where we will study more at length the different theories which have been proposed to explain inmunity.

4th. *After inoculation the animal survives; immunity has been acquired.*

(This point to be continued and discussed at length in February number.)

MISCELLANEOUS MATTERS.

THE DISCOVERY OF KOCH.

BY PAUL GIBIER, M. D.,
(Director of the New York Pasteur Institute.)

It is of certain discoveries, as it is of certain ideas ; there is a moment when they are in the air. As to the discovery of the cure of tuberculosis, in admitting its existence as an accomplished fact, in following, step by step, the progress of work executed, and of the discoveries made in bacteriology of recent date, we see that it was, so to speak, in sight. In France Messrs. Grancher and Martin had arrived, with the aid of injections of pure and attenuated cultures of tuberculosis, at the production of a certain number of refractory cases in rabbits. Messrs. Richet and Hericourt, by repeated injections of sterilized cultures of the bacillus of tuberculosis, have rendered rabbits refractory to the inoculation of tuberculosis. I have, myself, in 1886 and 1889, begun experiments that I had to interrupt at different times ; but in the course of which I had made this remark : that the bacillus of tuberculosis secreted a substance which is extremely detrimental to its development and even to its life. Thus, when we deposit bacilli of tuberculosis on a medium where they cannot develop, we will, if other germs do not come to destroy them, find them alive again after several months, whilst, on the contrary, the more favorable the nutritive material is to the development of the same organism, the shorter will it live therein. After a few weeks all traces of life have disappeared ; the bacillus can no longer grow on the most favorable culture media, and its injection in animals remains negative.

It may be remarked again that, if we cultivate the bacillus of tuberculosis in striæ in a tube of *gelose* a little large, colonies do not extend over a few millimeters in width, and never reach the edges of the preparation unless an accident has dispersed the first colonies developed, over all the surface of the culture. What prevents the microbe from invading all the nutritive material if it is not a soluble substance secreted by the germ and infiltrating the culture medium? The bacillus of Koch, among other species of bacteria studied until now, is the one that gives the greatest quantity of soluble matter in alcohol and ether.

After the researches of Hammershley of Bern, the chemical analysis of the bacilli give water 88.82 per cent., solid substances, 11.18 per cent. Of these solid substances 22.7 per cent. are soluble in alcohol and ether. Inoculations of these extracts practiced on animals have shown that they contained a toxic matter with tetanic properties. It is to be noted that in persons inoculated with Koch's lymph, besides the febrile movement, the patients exhibit occasionally cramps and stiffness in the limbs.

These observations, and a few experiments that I have made, as well as the facts presented by Messrs. Grancher and Martin, Hericourt and Richet, authorize us to give this opinion: That the albumenoid extracts of the cultures of the bacillus of tuberculosis form the base of the lymph of Dr. Koch, and if the latter does not hasten to publish the complete results of his investigations the priority of the discovery might be contested.

STUDY OF TUBERCULOSIS IN FRANCE.

The great excitement, due to the announcement of Koch's discovery of an agent capable of *curing* tuberculosis, has, it seems, completely overshadowed a public statement, made later, of the admirable results obtained by scientists in Pasteur's Institute, in their experiments made with the object of *preventing* the same disease by vaccination.

Messrs. J. Grancher and H. Martin, soon after the report of Dr. Koch, as made at the Medical Congress of Berlin, published a letter explaining that on the 19th of November, 1889, they deposited at the office of the Academy of Medicine (Paris) a sealed document, giving their success in arresting, for a long time, the evolution of tuberculosis in rabbits. The process of vaccination was after the anti-rabic system of vaccination of the great French master, Pasteur, that is, by the inoculation of graded virus. Virus number 1, say, may represent the most virulent, and 2, 3, 4, 5, 6, 7, 8, 9, 10, being successively decreasing. The introduction of the material was done as in hydrophobia, by beginning with the weakest, and at intervals introducing some other stronger, and again still stronger. After such vaccination, even the introduction of the strongest tuberculous virus, according to the quickest method of infection known, namely, introduction of tuberculosis bacilli in the veins failed to produce the usual specific lung, liver and spleen lesions.

Thus we have, it seems, another method in sight by which mankind may combat the terrible ravages of tuberculosis ; and it is an important one, too, which promises great good to the people.

We hope that Messrs. Grancher and Martin will be successful in their endeavors to give the world a prophylaxis against the worst plague to which man and beast are liable. Thus, with a cure from the German masters, a preventive from the French savants, the universe will be doubly blessed, and the nations owe a still greater debt of gratitude to the discoverers and science.—Ed.]

THE TREATMENT OF SKIN DISEASES IN GENERAL PRACTICE.

BY J. W. BANKS, M. D.,
Columbia, Mo.

There is scarcely anything more troublesome to the general practitioner of medicine than the great variety of skin affections that come to his notice. Firstly, the patients in such cases use usually all sorts of nostrums before presenting themselves for treatment by a competent physician ; secondly, when they do request treatment they scarcely ever will follow a regular course of treatment ; and, lastly, the general practitioner is not, as a rule, so situated as to study the cases as closely as they should be or to follow the results of his treatment as a specialist can. As a result he frequently finds himself confronted with difficult and tedious maladies, and he is forced, too often, by the circumstances and facts alluded to, to experiment more or less before success is attained. At least, I can conscientiously say, that such has been my experience in many years of practice.

Since the progress made in medicine, because of the discovery of the action of germs on the economy, it strikes me that many skin affections, besides those known to be primarily due to microbes, are at least much complicated by the access of injurious germs into the seat of the diseased localities of the tegument. This I believe to be surely the case in the eruptive maladies, whether primarily due to a specific virus or not. Therefore, it seems to me that these possible factors ought to be taken into account in medical or surgical treatments, and such medicines used as combine the soothing, healing and sometimes the stimulating effects with the antiseptic and bactericide properties. In the last year I have applied this rule in my practice uniformly, and I am pleasantly confronted with a list of good results, fifty per cent. better than ever before ; successes indeed, where heretofore I failed utterly. Of course I have not abandoned constitutional treatment where such seems absolutely necessary, but my local applications have been much modified, and many cases in which two years ago I thought internal treatment indispensable have since yielded with only local medication. The principle I follow is first perfect cleanliness and then applications preventing the growth of germs in the diseased parts, instead of using the ordinary skin ointments so-called, under which microbes often flourish. But these cases explain themselves.

I herewith present a few instances of inveterate, persistent affections, some of which I had previously failed to cure with the time-honored local prescriptions in conjunction with the iodides, mercurials, and the arsenical preparations.

I had long since recognized the beneficial action of vegetable tar in skin diseases, but never before had I encountered a preparation containing it, which was not objectionable and often valueless because of its color, its sticky and granular condition, and pungent odor. The preparation I have used so largely of late is Tarro-Petrolene (or Petrolene Comp. No. 1, refined), in which tar and petroleum are so beautifully and homogeneously blended as to form a veritably desirable salve, unequaled in my estimation either as an ointment or a base of ointment for maladies of the skin and scalp.

Patient No. 1.—Curtis R., scald head, Crustea Lactea, 3 months' standing; attack very obstinate with complete loss of the hair. Yielded very readily to an application of Petrolene Comp., or Tarro-Petrolene No. 1, each night for one week.

Patient No. 2.—Mattie B., congenital syphilis. Applied Petrolene Comp. over the eruption which was all over the body with great loss of epidermis about nates and groins. Kept up application for 2 weeks with minute doses of calomel internally. Syphilitic eruption all disappeared and child now apparently in good health, assimilates food readily and growing very fleshy.

Patient No. 3.—Cornelia R., aged 40 years, with local tetter on the forearm; a washerwoman. Eruption very irritated by contact of soap and hot water. General health good. Used Petrolene Comp. for 2 weeks every night before going to bed, and all appearance of tetter has disappeared.

Patient No. 4.—John D., secondary syphilis. Eruption scaly, extended over face and body. Used Petrolene Comp. over the eruption with Iodide Pot. and Per-Iodide of Mercury internally, and in 4 weeks no syphilitic symptoms.

No. 7.—Eczema of the face in child 4 years old. Yielded to application of Petrolene Comp. applied 2 weeks.

No. 8.—George R., Acne of face. A very obstinate case. Been treating him for 3 weeks with Petrolene Comp., with Iodide Pot. and Per-Iodide of Mercury; patient almost entirely cured.

The above are a few of the cases I have kept notes on in treatment, and where treatment has been fully adopted satisfaction has been complete or encouraging.

SCIENTIFIC GLEANINGS.

STRUCTURE OF BACTERIA AND ALLIED ORGANISMS.*—Prof. O. Butschli deals with the finer structure of bacteria in a monograph, the object of which is to demonstrate the proposition that these organisms are nucleated bodies. The ultimate structure of these minute bodies is divided into two parts, an outer harder layer and an inner softer part, the central body. The former is further distinguished from the central body by being less stainable with the ordinary pigments. In both a reticulated appearance is discoverable with high magnifying powers, and on section this reticulation or network imparts a honeycombed appearance to the object. At the points of intersection of the network are frequently seen red globules of variable size. These red globules, which are very frequent in the sulphur bacteria, are supposed to consist of sulphur in some vascid condition. Their exact significance seems doubtful. One point on which the author expresses himself confidently is that when a flagellum is present it is continuous with the outer layer. The central or chromatic part of the micro-organism is to be regarded as the nucleus.

MICROCOCCUS VERSATILIS.*—This micro-organism, which Dr. C. Delgado and Dr. C. Finlay presume to have some direct connection with the appearance of yellow fever, has been obtained by the usual methods, not only by these authors, but also by Dr. Sternberg and others from the juices and tissues of persons affected with or dead of yellow fever. The authors have obtained it from the serum of artificial blisters, and Sternberg from the skin of healthy, but unwashed, persons living in places where the fever is endemic. The name originally given to this micrococcus by Delgado and Finlay was "Tetragenus febris flavæ," but they now accept the new name proposed by Sternberg.

The best procedure for obtaining *micrococcus versatilis* is to inoculate peptonized gelatin and keep it in the incubator at a temperature of 30°-32°. When a deposit forms at the bottom of the gelatin, gelose in Esmarch's tubes is inoculated therewith, and the tubes kept at a temperature of 30°–32°. Colonies began to appear in from two to six days, according to the season of the year and the activity of the germs cultivated. The colonies are round, with smooth edges, transparent, of straw-yellow color, but become opaque as they grow older. The colonies below the surface are more fusiform and deeper colored.

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*Journal of Royal Microscopical Society.

The name *versatilis* was suggested by the different appearances presented by the colonies, their variable color, and the diverse sizes of the micrococcus, which is chromogenous, and develops in true tetrads.

ACTION OF THE GASTRIC JUICE ON PATHOGENIC MICROBES.*—MM. J. Strauss and R. Wurtz have examined the action of the gastric juice of the dog, man and sheep on the bacilli of tubercle, anthrax, enteric fever and cholera. The gastric secretion was placed in test-tubes, inoculated with the microbes, and kept at a temperature of 38° C. After various periods of time, inoculation experiments in guinea-pigs and rabbits showed that tubercle bacilli survived the action of the gastric juice up to six hours sufficiently well to produce a general tuberculosis. From 8 to 12 hours a tubercular abscess was formed at the inoculation site, and this quickly healed. After 18 hours the bacilli were either dead or had lost their virulence. Anthrax bacilli without spores were killed in 15 to 20 minutes, and the spores died after thirty minutes. Under similar conditions typhoid bacilli died in 2 to 3 hours, and cholera bacilli after 2 hours.

Further experiments with hydrochloric acid in the proportion of 0·9, 1·7, and 3 per thousand on anthrax, cholera and typhoid bacilli gave similar results to those obtained with gastric juice. Hence the authors conclude that the antiseptic effect of the gastric juice is to be ascribed to its containing hydrochloric acid.

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*Journal of Royal Microscopical Society.

REMEDIES AND CLINICAL REPORTS.

METHYL VIOLET.—This substance, prepared now by Mercks, chemically pure, under the name of "Pyoktanin," seems an excellent antiseptic in all cases of suppuration. Gonorrhea, ulceration of the cervix and uterus, shankers, granulated eyelids, etc., are reported as having been successfully treated, by several competent physicians. The substance is used in the average proportion of 1 to 2,000. It is not irritant, scarcely toxic, and yet strongly bactericide. The first experiments with it were made in Strasburg.

TARRQ-PETROLENE (Syn.: Petrolene Compound).—This ointment (used also as a base) seems a remarkable, healing, and at the same time antiseptic preparation in skin diseases. Reputable physicians report cures of tetter, eczema and scalp and skin affections of a parasitic nature, or with bacterial complications. This ointment is perhaps the only one containing vegetable tar so smoothly blended or incorporated. The purified Petrolene Compound or Tarro-Petrolene, grade No. 1, is amber color, and has rather a pleasing odor ; the crude, or No. 2, is darker, and used in veterinary practice. In animals it is reported as efficacious in skin diseases also. It is frequently used alone or as a base for iodine ointments in so-called scratches in horses.

KATHARMON.—This antiseptic or bactericide lotion is getting in general use in various pathological discharges of the mucous membranes. Its success seems to be greater in nasal catarrh and vaginal catarrh. Altogether, very favorable reports come in from practitioners.

IODOFORM.—This drug, once thought to be highly antiseptic, is losing ground and is being replaced mostly by Iodol, which has much the same properties, is apparently a superior bactericide and has none of the very objectionable and disagreeable odor of the former.

PAMBOTANO.—In Italy this substance is rapidly taking the place of quinine in malarial fever, and well it may, for, judging from most trustworthy reports, it has very remarkable effects.

In many cases—even some of inveterate character—only one single dose was sufficient to cure the disease radically. In fact, in its use by the Italians and French who employed it, it seems the rule to give but one or two doses even to patients who had suffered for months, periodically or constantly. Pambotano is not a substitute for quinine in case of periodicity, but it seems very nearly a specific in malaria. Why not try it in this country?

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FORMULAS.

NASAL CATARRH.

Dr. J. J. Stephens, of Clinton, Mo., recommends the following in nasal catarrh.

First he prescribes a mercurial purge, following it with a saline cathartic. Then he uses douches, in which Katharmon seems the principal factor. After the action of the cathartic he uses the following :

℞ Katharmon,	℥ ss.
Sodii Chloride,	grs. ii.
Aq. Distil,	℥ iss.

Sig.—One tablespoonful in 12 oz. of warm water as a douche.

ANTISEPTIC AND DEODORIZING MOUTH WASH.

F. W. Peck, druggist, Columbia, Mo., highly recommends the following lotion for the mouth :

℞ Acid. Carb.,	m xx.
Acid. Acetic,	ʒ i.
Tinct. Myrrh,	ʒ ii.
Honey.	
Listerine, aa.	℥ i.
Aqua dist. ad. qs.,	℥ viii.
Misce.	

SKIN ERUPTIONS AND COMPLICATED, INDOLENT, REBELLIOUS SKIN ULCERATIONS.

Dr. P. Paquin prescribes the following in such cases and recommends it in man and beast :

℞ Pyoktanin,	grs. ii.
Resorcine,	ʒ i.
Tarro-Petrolene,	
(Petrolene Co. No. 1 or No. 2)	℥ iv.
M. Ft. ung.	

Sig.—Wash thoroughly, wipe dry and then apply ointment in friction daily.

TECHNIQUE.

Preparation of nutritive agar.*—In the course of experimental work Dr. V. A. Moore found that when the stems of agar were cut into small pieces and boiled in a fluid containing no coagulate material, that it was entirely broken up and the soluble portion dissolved. The insoluble particles that remained suspended in the liquid were easily and completely removed by the addition of egg albumen, and subsequent boiling and filtering. From these facts a method for the preparation of nutritive agar was derived, which consists in first preparing the neutralized beef-infusion-peptone, and thus getting rid of all coagulable material before the agar is added. This process is effective in greatly diminishing the time and attention required for the preparation of this medium. The medium can always be made of the same consistency, as all of the agar that is added is dissolved. It remains free from precipitates when sterilized, and its nutritive qualities are as favorable to bacterial growth as when it is prepared after the original method.

(1) *The preparation of the beef-infusion-peptone.*—The method of preparing this liquid is practically the same as that already in use in most laboratories. Finely chopped or ground beef (freed from fat) is macerated in distilled water for from 12 to 18 hours in a cool place. The distilled water is added in

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*From the Journal of the Royal Microscopical Society.

the proportion of 200 ccm. to each 100 grams of beef. On the following day the liquid is separated from the meat by straining it through a coarse linen. The simple beef-infusion thus obtained should be equal in quantity to the amount of water added ; if it is not, the deficiency can be restored by the addition of distilled water. To the beef-infusion is added one per cent. peptone, 1-2 per cent. sodium chloride ; and if it is desirable to make it alkaline, a sufficient quantity of a normal solution of sodium carbonate to give it a weak alkaline reaction. The liquid is then boiled for thirty minutes in a water-bath, cooled, filtered and distributed in Erlenmeyer flasks plugged with cotton-wool. If only a small quantity of agar is to be made at once, 250 ccm. is found to be a very convenient quantity to put in each flask. It is then sterilized by boiling for one hour each day for three consecutive days. It need not be sterilized if it is desirable to prepare the agar at once. As the beef-infusion-peptone is also employed as a liquid medium in the cultivation of bacteria, very little time is lost in preparing an extra quantity of this liquid to be used in making the agar.

(2) *The preparation of the agar.*—To an Erlenmeyer flask (a glass beaker or agate or iron vessel may be used) containing beef-infusion-peptone, as prepared above, 1 per cent. of *very finely chopped* agar is added. The flask is then placed in a water-bath and boiled vigorously for two hours. At the end of that time the agar is dissolved, and the liquid is allowed to cool. When a temperature of 40°–45° C. is reached, the white of egg is added in the proportion of one egg to 250 ccm. of the liquid. After the albumen is *thoroughly* mixed with the liquid agar it is returned to the water-bath, and again boiled for two hours. It is of much importance that the albumen is evenly distributed throughout the mass before it is coagulated. It is now ready to be filtered. The egg albumen is coagulated in very firm masses, leaving the liquid perfectly clear. The coagulum is removed by filtering the liquid through fine Japanese filter–paper or a layer of absorbent cotton, as a 1 per cent. solution of the agar does not pass readily through ordinary filter-paper. Should a weaker solution of the agar (1–2 to 3–4 per cent.) be desired, its filtration can be

accomplished by the ordinary method. A hot filtering apparatus is not necessary. The clear filtration is now ready for distribution in sterile cotton-plugged tubes.

The agar is sterilized by discontinuous boiling in a closed water-bath for three consecutive days. If small tubes have been used containing not more than 7 ccm. each, five minutes' boiling each day is sufficient. If larger tubes are used, they should be boiled for a longer time. Or it may be sterilized by steaming each day for from five to ten minutes after the agar has become liquefied for the same number of days. After its sterility has been tested by allowing it to stand in an incubator for several days, it is ready to be stored away until required for use. It has been customary in this laboratory, in order to prevent the evaporation of the agar by long standing, to dip the lower end of the cotton-plugs in hot sterilized paraffine, and to store the tubes in a cool, moist chamber.

METHODS OF RECOGNIZING CYSTICERCI OF TÆNIA SAGINATA.*—M. A. Laboulbene has a note on the means of recognizing the cysticerci of *tænia saginata,* which are the cause of "measles" in veal and beef, and which are often so difficult to detect on account of the rapidity with which they dry on exposure to the air. He finds that meat which has become quite leathery will easily reveal the *cysticerci,* if it contain any, by being placed in water acidified with acetic or nitric acids, or in a mixture of water, glycerine and acetic acid. By this means the parasites can always be detected, and if the meat be carefully heated to 50° or 60° C. it is always fit for human food.

LABORATORY NOTES.

NEW YORK, October 15, 1890.

Dr. Paul Gibier, Director of the New York Pasteur Institute, begs to inform you of the results of the preventive inoculations against hydrophobia performed at this Institute since its opening (February 18, 1890).

To date 610 persons, having been bitten by dogs or cats, came to be treated. These patients may be divided into two categories :

---

*Journal of the Royal Microscopical Society.

1st. For 480 of these persons it was demonstrated that the animals which attacked them were not mad. Consequently the patients were sent back after having had their wounds attended, during the proper length of time, when it was necessary. *Four hundred patients of this series were consulted or treated gratis.*

2d. In 130 cases the anti-hydrophobic treatment was applied, hydrophobia having been demonstrated by veterinary examination of the animals which inflicted bites, or by the inoculation in the laboratory, and in many cases by the death of some other persons or animals bitten by the same dogs. ALL THESE PERSONS ARE, TO-DAY, ENJOYING GOOD HEALTH. *In eighty cases the patients received the treatment free of charge.*

The persons treated were :

64 from New York,
12 from New Jersey,
12 from Massachusetts,
8 from Connecticut,
9 from Illinois,
3 from Missouri,
3 from N'th Carolina,
3 from Pennsylvania,
2 from N. Hampshire,
2 from Georgia,
2 from Texas,
1 from Maryland,
1 from Maine,
1 from Kentucky,
1 from Ohio,
1 from Arizona,
1 from Iowa,
1 from Nebraska,
1 from Arkansas,
1 from Louisiana,
1 from Ontario, (Can.).

With kindest regards of the Pasteur Institute,

PAUL GIBIER.

NEW PUBLICATIONS.

The text-book on Comparative Physiology, by Professor Wesley Mills, of McGill University, Montreal, Canada, is timely. In the last two years two excellent and much-needed works on the subject have been written: one by Prof. Mills and the other by Prof. Smith, of Pennsylvania University. Both filled a gap in English medical literature which had been felt for many years by the students, and practitioners of comparative medicine and surgery, but the smaller volume of Prof. Mills, recently published by D. Appleton & Co., is more compact and perhaps the most suitable text-book ever printed on the subject of which it treats. P. P.

ADVERTISEMENT.

Our magazine we shall endeavor to keep of the highest character, scientifically and practically, and we must refuse, with due respect, all advertisements of medical preparations, the legitimacy of which is questionable, or which do not receive the indorsement of some reputable member of the medical profession. Not having published this fact in our prospectus, we beg to apologize for having returned the MSS. of a gentleman whose "ad" we had solicited before knowing the nature of the preparation to be advertised. On the same principle we must refuse space to questionable medical institutions of any kind.

But, on the other hand, believing that the duty of a physician is to relieve sufferings, and to prevent them and cure them by *any* or *all* legitimate methods, we consider it our duty not only to publish advertisements, but also to aid with all our might in establishing the actual virtues and properties of worthy articles among the medical world and the public, by the publication of clinical reports from *authorized sources.*

Our readers, therefore, may rely on whatever may appear of such character in any part of this magazine.

We issue 5,000 copies of this edition and shall issue at least 1,000 copies monthly hereafter, reaching every state and territory in the Union.

We respectfully solicit a share of the patronage of all deserving institutions, firms and individuals who usually advertise in medical and scientific journals.

THE BACTERIOLOGICAL WORLD.

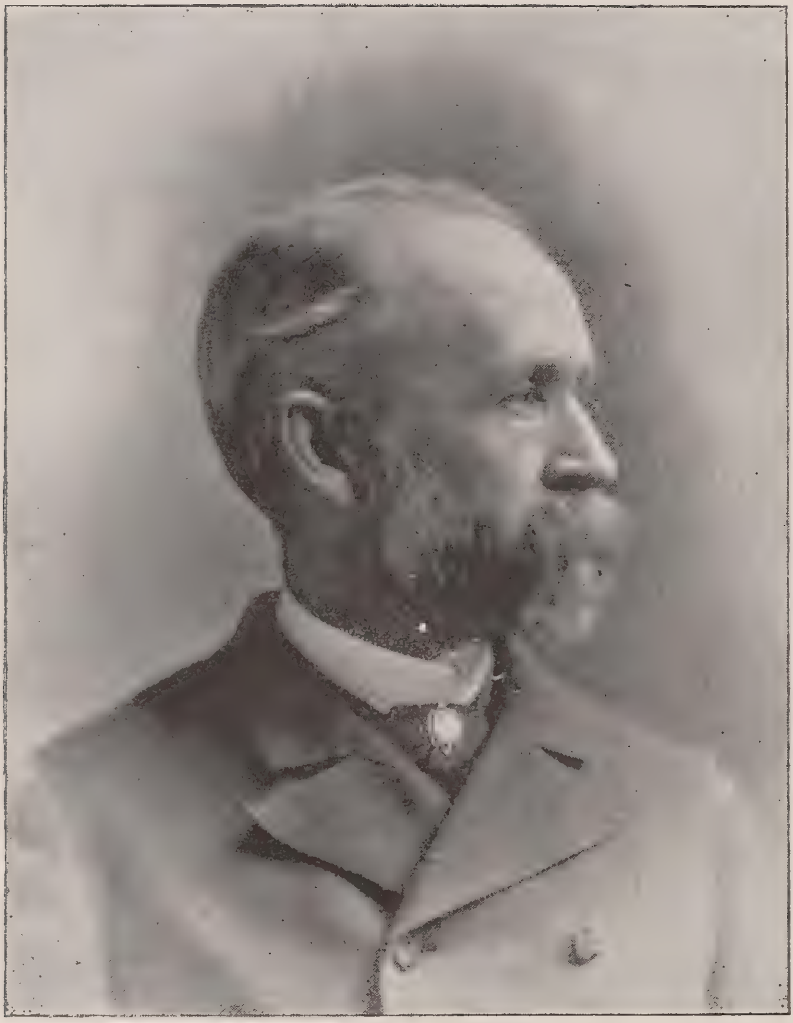
IMPORTANT NOTICE TO SUBSCRIBERS, EXCHANGES, ETC.

We had the intention of mailing nearly all of our first 5,000 copies to a selected list before January 1st, but, since circulating our prospectus, the medical public has so generously and so promptly responded, that we have decided to distribute about 3,000 within that date, including the subscribers then listed, and to mail the remainder gradually, less 300 copies, as subscription may be received, within the months of January and February, thereby affording opportunity to examine the magazine, and keeping faith with our engagements. EXCHANGES will kindly notice. If, after the whole issue is exhausted, we still receive subscriptions we may decide to issue another edition.

We are now making arrangements with the publishers of some of the leading medical and scientific periodicals to the end of offering the BACTERIOLOGICAL WORLD with one or more magazines at reduced terms. Our publication being a necessary adjunct to medical, hygienic, veterinary and certain other scientific journals, we hope by such means to bring our infant more prominently before the interested public.

Send postal notes, money orders or checks on New York or St. Louis. Never send check on local banks as they cannot be collected without paying 25 cts. exchange.

EDITOR AND PUBLISHER.



MR. GEORGE MILLER STERNBERG

THE BACTERIOLOGICAL WORLD

A Monthly Illustrated Magazine Devoted to the Study of Micro-Organisms and Specific Maladies.

Original articles, clinical reports, books for review, exchanges, scientific correspondence, should be addressed to the Editor of the BACTERIOLOGICAL WORLD, Columbia, Missouri.

Subscriptions, advertisements, and all business matters are attended to by Dr. T. J. TURNER, Mexico, Missouri, to whom remittances should be made. However, all moneys sent to the BACTERIOLOGICAL WORLD Co., Columbia, Mo., will be received and promptly acknowledged.

Authors of original articles published in this magazine will be entitled to twenty copies of the number containing it, provided, that they request the same in writing when sending the communication. REPRINTS AT ACTUAL COST.

Except the three months' trial subscription, at 75 cts., no subscription will be received for less than one year, commencing in January.

DISCONTINUATION :—At the end of the year we shall consider subscribers individually as wishing the magazine continued, unless they order it stopped in writing before the first of next January.

COLLABORATORS:

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PROF. PAUL SCHWEITZER, Ph. D., Missouri University.
PROF. T. J. BURRILL, Ph. D., Illinois University, Director of Department of Vegetable Mycology.

Vol. I. COLUMBIA, MO., U. S. A., FEBRUARY, 1891. No. 2.

EDITORIAL.

KOCH'S REMEDY AND OTHER TREATMENTS OF TUBERCULOSIS.

The press has been so full of this subject of late that it seems superfluous to add anything more. Yet this question is directly in line with the duties of the BACTERIOLOGICAL WORLD, and it devolves upon us to review it to date.

The excitement has now subsided, the confusion has disappeared in a great measure, and we can see the facts as they are.

In a nutshell the situation is this :

First. Koch's lymph is successful in the treatment of localized tuberculosis, particularly in the comparatively mild form known as lupus.

Second. It may be beneficial in a measure in cases where the baccilli have attacked the lungs mildly.

Third. It may be dangerous in serious cases, when internal organs are involved.

Fourth. It is dangerous in the hands of indifferent, careless practitioners.

Fifth. It is dangerous to use it indiscriminately for diagnostic purposes.

There is no question, however, that the Koch discovery is one of great value from a scientific standpoint; but much is to be done in a practical sense to make it as useful as we had hoped it would be, at an earlier date, when we were informed by the Germans, that the state was preparing to supply the drug trade with Koch's lymph under the name of "paratoloid." We had expected that the scientists interested would not allow this to be done unless they were sure of safe results. It seems that this commercial aspect of the case was prematurely countenanced.

On the whole, from a rational basis, one could scarcely expect, at this early date, any more favorable result than was obtained. All things considered, Koch's remedy stands on a basis which insures its earnest, respectful consideration and trial by the most trustworthy of the medical fraternity, with a good prospect of success in certain cases of tuberculosis. Only when the full properties and limitations of the new agent have been clearly established will it be possible to realize the benefit of it to mankind.

But, whilst we, American physicians, make so much of this achievement, we have neglected to give the deserved encouragement to home investigators who have made striking discoveries in the very same line of work.

Koch's great name carried his results to every part of the world, and they were received with confidence, because it came from Koch; it would have been different had it been from a more humble origin. Still, with all his reputation, Koch's achievement should not so overshadow every other man's works as to relegate them to the rear. It is particularly humiliating, and positively painful, that deserving American scientists who, themselves, are quoted abroad as authorities, barely receive recognition from the American press in general.

Dr. Samuel G. Dixon modestly announced, in 1889, that he had succeeded, by a scientific process, in producing immunity in small animals against tuberculosis, by the inoculation of a solution of certain principles extracted from the baccilli of tuberculosis in a given morphological condition. The immediate effects of this inoculation were very similar to those produced by Koch's lymph.

Dr. Kraft, of Cleveland, Ohio, is quoted as having produced practically the same thing with a substance that he terms lymph.

Dr. D. E. Salmon, Bureau of Animal Industry, and his colleague, Dr. Smith, announced, in 1887, their experiments in producing immunity against a bacterial disease, hog-cholera, by the inoculation of sterilized cultures ; and, in 1889, Dr. Schweinitz, of the same institution, reports the production of immunity with chemical substances formed during the growth of baccillus of hog-cholera. We reprint the latter's report in this number.

Dr. Frank S. Billings has applied for two years a process of inoculation to prevent swine-plague, which he claims is also a chemical substance, though, unfortunately, no literature has ever been published by the Doctor verifying this point for the benefit of science.

Lastly, Drs. Shurley and Gibbes, of Detroit and Ann Arbor, Michigan, have formulated prescriptions of a purely chemical nature, which have had, it seems, success even more remarkable than the Koch remedy.

All these are scientific results brought about by American brains, and it is rather strange that we do not encourage more our own deserving enterprising men (who, by the way, are not all backed by government subvention, and, therefore, often work under great difficulties).

Treat everyone with equal justice and consideration ; give credit fully "to whom credit is due," and let us remember that it is not necessary to live abroad to possess qualifications necessary to succeed in medical and scientific investigations. "Science has no home, but the universe at large."

The enthusiasm that arose in the breast of every lover of medicine and human nature spread wildly throughout the universe, when it was learned that no less a man than Koch, himself, had announced his belief in being able, in the near future, to cope with tuberculosis; few were capable of resisting the temptation of expressing their gratitude to a man who prophesied such a boon to humanity.

The Bacteriological World expressed its feelings in the same vein at the prospects. Now, since learning more of the foreign discovery, and more of the results obtained by our own countrymen, we do not hesitate to say that our home achievements are equal to the Germans', to say the least; that some of ours seem to have priority in the line of Koch's discoveries, and that we feel equally enthused and grateful when we realize fully the depth and potentialities of the American discoveries. In weighing everything, we find, on calm reflection, that all these results have advanced medicine at a giant pace towards the solution of the question of tuberculosis.

COMPARISON OF KOCH'S REMEDY AND SHURLEY AND GIBBES' TREATMENT.

The Koch remedy, as explained by himself, though it is not absolutely clear just what principles it consists of, and the explanation does not reveal the process of the preparation sufficiently to allow exact repetition by others, yet it is given that the basis of it is an agent produced by the bacillus of tuberculosis itself. The action upon which its value rests is the disintegration and the exfoliation of the morbid tissues. The affected parts are destroyed. Now, this fact at once limits the utility of Koch's remedy to a comparatively few cases. For, in fact, how can we conceive that the disintegration, death, of a portion of an important internal organ may occur at a given moment with impunity. Such destroyed portions must act as foreign bodies, and must either be circumscribed by new tissues by nature's efforts, or absorbed or extirpated. In either case it is a serious question, and in many, the first sequence, if it did occur, would constitute a grave interference; the second does not seem possible in the majority of cases; whilst the last could scarcely be practiced. Would it be usually practical, for instance, to remove the exfoliated parts from a liver, or spleen, or intestines, or peritoneum, or the heart, or the brain, or the lungs, more or less affected or filled throughout with tubercles ?

Dr. Heneage Gibbes, in a recent paper before the Medical and Library Association of Detroit, Michigan, draws attention to these points in a forcible manner.

Furthermore, he presents unanswerable arguments against the application of the remedy in many cases of tuberculosis of the lungs, by his very accurate division of the forms of the disease. Basing a classification on morbid histology, we must admit, as Prof. Gibbes so clearly points out, that there are two distinct forms of consumption ; one in which the baccilli are numerous and scattered through a variable portion of tissue ; the other, in which the disease consists of nodules, made of new formation in which the baccilli are more scarce. This fact precludes the use of Koch's remedy in the first kind of consumption, and limits it in the other. Suppose the half of one lung is affected with the acute, inflammatory, scattered, miliary tuberculosis, what would be the result of a treatment causing the death of this part in total ?

And now comes Virchow, who says that Koch's lymph may, under some conditions, cause, in a degree, the generalization of tuberculosis where it before was localized.

Again appear authoritative statements to the effect that for diagnostic purposes, the reaction of Koch's lymph may prove dangerous. What then is there left, in which Koch's remedy, so far as its action has been explained, may be truly beneficial ? Local tuberculosis, viz.: *Lupus, cutaneous, bone, gland, articular and incipient tuberculosis.*

The fact remains, however, that the remedy does actually cure tubercles, and this, in time, may lead to more practical results in the treatment of consumption, generally speaking.

Shurley and Gibbes' treatment presents less objections ; it would seem that it could reach more cases, the only condition being that the destruction be not too great in the affected parts prior to treatment. In this case it is the cause alone that is removed and prevented from acting. The germ is, by the chloride of gold injection, so affected, that it ceases to multiply and scatter, and the tissues may regain their equilibrium. There is no dead matter suddenly left to act as foreign body ; there is no dangerous reaction. The results have been, from all accounts, very gratifying and promise more extensive application, perhaps, than any other remedy advanced to this date.

But, even if Koch's remedy should prove, in time, to be the least beneficial of all that have or may be brought to light, we must not forget that much of the honor and credit of the success reflects on the celebrated German physician, because all are and must be based on his discovery of the germ of tuberculosis and its properties.

STERNBERG.

George Miller Sternberg, Major and Surgeon, U. S. A. Born in New York state, June 8, 1838 ; graduated in medicine at the College of Physicians and Surgeons, New York City, in the spring of 1860 ; appointed Assistant Surgeon, U. S. A., May 28, 1861 ; Major and Surgeon, U. S. A., December 1, 1875 ; saw active field service during the War of the Rebellion and has seen much service on the frontier since ; appointed a member of the Havana Yellow Fever Commission of 1879 ; delegate from the United States to the International Sanitary Conference of Rome, in 1885 ; detailed by the President to make investigations relating to the cause and prevention of yellow fever in 1887 ; in pursuing this investigation visited Rio de Janeiro and Vera Cruz, and spent the greater portion of two summers in Havana ; elected President of the American Public Health Association in 1886. Is an Honorary Member of the Epidemiological Society of London ; of the Royal Academy of Medicine of Rome ; and of the Academy of Medicine of Rio de Janeiro. Is a Fellow of the American Association for the Advancement of Science ; and of the Royal Microscopical Society of London ; Associate Member of the *Societe Francaise d' Hygiene*, etc., etc.

Dr. Sternberg is one of the oldest and most distinguished bacteriologists in America. His reputation in this country and abroad is deservedly high. He has contributed, we believe, more than any other one man of our country to bacteriological literature. His past services in the medical world, and to the country at large, are great indeed, and it is to be hoped that we may continue to reap the benefits of his knowledge and experience for many years to come.

Sternberg is the author of numerous, excellent publications bearing on bacteria, among which we note as most important: "Bacteria" (Magnin & Sternberg); "Photo-Micrographs, And How to Make Them"; "Malaria and Malarial Diseases"; "Disinfection and Disinfectants."

NEW COLLABORATORS.

We take much pleasure in announcing to our readers the names of Dr. H. P. Loomis, Professor of Pathology, University Medical College; Pathologist to the Board of Health, New York City; Visiting Physician Bellevue Hospital.

Mr. B. T. Galloway, Chief of the Section of Vegetable Pathology, Department of Agriculture, Washington, D. C., and Editor of the *Journal of Mycology.*

In the next number we expect to have our list completed and to have the honor of giving a short biography of each of our collaborators.

NOTICE.

We refer our readers and all interested, to our club rates with other excellent publications. See index.

LESSONS ON BACTERIOLOGY.

(Copyrighted.)

BY PAUL PAQUIN, M. D., V. M.,
Missouri State University.

LITERATURE.

Cornil & Babès—Les Bactéries.
Prudden—The Story of Bacteria.
Prudden—Dust and its Dangers.
Thomé—Structural and Physiological Botany.
Mills—Comparative Physiology.
Bell—Comparative Anatomy and Physiology.

LESSON SECOND.—PART I.

THE CELL.

In some sense the cells are to organized bodies what the atoms are to unorganized bodies; namely, each are the constructive elements of the whole, and the energy proceeds from them. In chemistry, the atom is inferred, so to speak; it cannot be seen; but in histology the cell may be seen with magnifying instruments, and its size and shape examined, its life appreciated.

When an anatomist dissects a complex body, the tissues of a man, for instance, he finds a bony framework surrounded by muscles, themselves incased in tegument, and the whole provided with vessels, nerves, etc. He finds, besides, lodged in the several cavities, various organs obviously meant for different purposes. All these portions of the body, with such a variety of aspects, consistence and shapes, appear as though formed by very different elements.

The anatomist may search deeper, with much skill, in the tissues composing these different organs, and separate every fibre as far as possible with the naked eye, but he will fail to decipher the nature of the marvelous structure.

If, however, a microscopical investigation is made in the tissues by proper methods, the darkness gradually disappears, the obscure veil is lifted, and the vital elementary base of the admirable composition of the body of man stands revealed. It is found then, that, notwithstanding the apparently very different nature of the several portions, they all are formed of cells.

The white, compact, bony framework ; the pink, soft muscles ; the nerves ; the solid portions of the blood and lymph, all are made of cells. Thus, a complex body is simply an agglomeration of cells, which have been generated since the moment of conception, and gradually modified during their growth, to suit the needs of the different organs of the individual, until they have acquired the forms in which we find them in the tissues of the adult stage. The first cell was the ovum, at the expense of which were generated new ones ; these in their turn generated new ones, and so on, and so on.

From a typical cell usually of a definite, globular form as the ovum is, and the no less definite, rounded, primitive embryonic cells as exist in the embryo, we get, by process of evolution, different groupings of cells of various shapes, forming the several tissues which differ so materially in aspect and properties. The labor has been "specialized,"* and divided among the innumerable cells, forming the whole structure.

A muscle has the special function of performing various movements more or less rapid and more or less powerful ; its cells, therefore, are elongated and so endowed that they may cause energetic contraction, and relaxation of this organ. The red blood cells are loose, floating in the plasma of the blood, and individually have the power of absorbing oxygen in the lungs, which they afterwards convey to every portion of the body. The white blood corpuscles or leucocytes are also floating in the lymph and blood, wandering even through the tissues, and have the power of reproduction to such a degree, as to be capable to even produce new tissues, to fill the gaps made in the living body by wounds or disease.

We see, then, that a man's body is composed of cells, modified in shape, appearance and properties, and fitted for their special respective functions, or for the special functions of the organ, or fluids, of which they are the component parts. They are individually endowed with life.

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* M. Prudden.

As men in the construction of an edifice are divided, singly and in sets, for the purpose of performing different labors simultaneously, to erect a building more or less imposing, so are the cells of living things separated, or grouped, for the purpose of erecting and sustaining the living edifice.

Among the builders of a home, there are those who carry bricks to the wall, those who carry the mortar, those who do the woodwork, etc., etc., and foremen supervising and directing the whole force.

Among the cells building a complex organism there are the blood cells carrying oxygen to the tissues; there are the muscle cells building the soft muscular structure, etc., etc., and there are the cells of the nervous tissue, supervising and directing, as it were, the whole force. And, somewhat as specialists in all vocations become experts in their line, and unfit after a time for any other labor than their specialty, so do the living cells, as I have just stated, become, by evolution, specialists unfit for duties other than their respective specialties.

The bone cell, for instance, has lost the power of reproduction whilst the lymph cell has retained it. The muscle cell has developed remarkably, to the exclusion of others, the power of motion, whilst the nervous cell has become endowed with mental energy and sensibility of the most wonderful character.

The same cellular foundation underlies all complex living things, whether of the animal or vegetable kingdom.

We gather, then, from what precedes in this lesson, that, whilst a complex living being of whatever reign or species, is endowed as a whole with diverse properties more or less pronounced, it owes all to the different special properties, and the activity of numberless cells, all working co-ordinately for their own lives and the benefit of the individual.

We see that the minute living organisms composing the body of an animal, or the trunk of a tree, are joined together for an important object, *i. e.*, the propagation of the species, and it will be apparent too, that, at the outset, the primitive, component cells of the individual must be beings of a low organization. The ovum, indeed, is not unlike some little animal living masses, unicellular beings of the ponds,—the amœba,—which never develop beyond their first natural condition, and propagate themselves by the reproduction of new, independent, separate cells. Some of the cells of the animal body retain this low organization until the death of the individual. The leucocyte, whose function we have seen and which is so essential to the life of the whole, remains much as an amœba, and moves in the liquids of the body as the amœba moves in water. This cell has retained its power of reproduction as already stated; when a breach occurs in the tissues it groups its successive progenies together, and fills it with tissue formed by them.

In the development of a complex being, then, the principle involved is the grouping of innumerable, individual, successive cells, originally from a common first parent, the ovum, each having life independently of the other; the relation existing between the largest and most complex bodies, and the smallest and most insignificant forms, lies in their *common cellular basis.* A man is related to the microscopic, unicellular, jelly-like mass known as the *amœba* inasmuch as he himself originated from such a mass; his body is the product of the like, and in the canals supplying it with nourishing fluids float constantly certain lowly cells with amœboid movement.

If we want to trace the relationship more closely, let us descend from man down to the most minute being (or *vice versa*), and examine as we proceed the various intermediate forms of the downward scale (or upward scale).

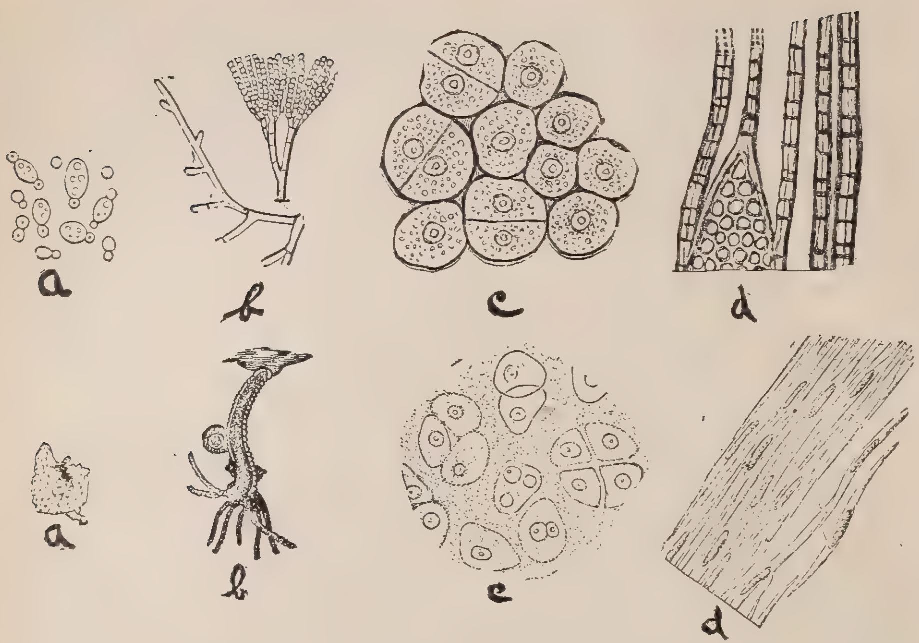

Figure 1. A series of vegetable cells and tissues and a series of animal cells and tissues, showing unicellular organisms as well as cellular structures of higher beings of both kingdoms. First row, *a* yeast plant (torula cerevisiæ) one-cell vegetable mentioned in the text; *b*, common green mould (penicilium glaucum), widely known microscopic plant composed of but few cells; *c*, section of fig tissue, showing cellular arrangement; *d*, longitudinal section of maple wood showing arrangement of fibres made from cells.

Second row, *a′*, amœba, a common microscopical, unicellular, jelly-like animal resembling the white blood corpuscle; *b′*, fresh water polyp (hydra viridis), animal made of a little sac of jelly composed of comparatively few cells; *c′*, a section of cartilage tissue of an animal showing disposition and appearance of cells; *d′*, section of intestinal muscle showing the grouping of fibres constructed by the cells.

(Borrowed from Wyeth, Bell, Thomé, Mills.)

From the highest being to the lowest it is only a question of cells. The highest is constituted by a more perfect community of cells, among whom the division of labor has been such as to produce particular, pronounced skill for particular functions; the lowest is a single, independent being doing by itself everything necessary for its existence, but doing "nothing particularly well except reproduction." As a consequence the higher the organism, and the better its component cellular bodies have been trained, specialized by evolutionary influences, the more perfect is the whole living system; and, the lower the organism, the more imperfectly it performs the acts necessary for its existence.

Life in a complex body does not exist as a unit as it were, for the whole individual, but it exists in the protoplasm of each and every cell forming it.

The classes of living things, then, considered from a structural point of view are only two: The *unicellular* organisms and the *multicellular* organisms. This is true of the vegetable and animal kingdoms. (See Figure 1.)

A plant may be formed by either only one cell as the yeast plant (Figure 1, *a*, or torula saccharomyces cerevisiæ) which consists of an oval cell about 1–3000 of an inch in diameter, containing a semifluid granular protoplasm, surrounded by a transparent envelope, and which reproduces by fission or budding,—each severed portion, or bud, becoming finally a new, independent yeast plant; or a plant may be formed of only a few cells, as the penicilium glaucum (Figure 1, *b*); or it may be an agglomeration of a variety of innumerable cells as in any highly organized plant (Figure 1, *c* and *d*).

On the other hand an animal may consist also of only one cell as the amœba (Figure 1, *a′*), which is a little mass of nucleated protoplasm that reproduces by fission and occasionally by budding, thus forming separate new individuals; or it may be a little higher in the zoological scale, and be formed of a comparatively small number of cells as the polyp, a greenish or reddish animal about ¼ of an inch in diameter, attached to weeds in water, constituted by a kind of sac formed by an internal and an external layer of cells, throwing out tentacles, and yet capable of contracting itself into a globular mass (Figure 1, *b′*); or it may be an aggregation of modified cells as in more complex and highly organized subjects, large animals and man. (Figure 1, *c′* and *d′*.)

But there are beings so small, and whose properties are so difficult to appreciate, that it is practically impossible to distinguish to what reign they belong, solely by the aid of the microscope.

Early in this century, Bory de St. Vincent, and later Haeckel, created a new intermediary kingdom in order to overcome the difficulty: the *protista*, implying that this class of beings includes the first animals that appeared on the earth.

This new kingdom, whether it has or has not reason to be, remains to be determined. Certain it is that the exact boundary between vegetable and animal kingdom is not absolutely demonstrated among the lower organisms. We find, often, micro-organisms whose place in the two old kingdoms is difficult to establish. It is among this class of beings that we find the microbes (schizomycetes, bacteria, etc.).

True, some high authorities have committed themselves, and placed most of bacteria in the vegetable kingdom, apparently with sound reason, but still the evidence is not convincing in all cases, though it seems to be in most of them. It is well to remember, too, that here, perhaps, lies the key to the solution of the relation between the cells of the vegetable and animal kingdoms. Indeed, when we descend from the highest vegetable to the microbe, and the highest animal to the microbe, we come to a focus, and meet at one point an individual that often seems either or neither, as in the following diagram.

This long story about the cell may seem a superfluous digression. It is in fact a digression, but its utility is apparent in showing the relation of all living beings, through their cells, and it will be more appreciated further when we proceed to study the relation of microbes to tissues.

PART II.

SCHIZOMYCETES IN GENERAL.

Distribution.—At the bottom of the vegetable scale we find the algæ and the fungi now known under the common term of *thallophytes*. The algæ and the schizomycetes form a parallel series of beings, but the former usually contain chlorophyl, and the latter usually do not. The algæ, therefore, are capable of preparing, manufacturing in fact, like other plants provided with chlorophyl, the nutrition necessary for their development. The schizomycetes, on the other hand, can live only at the expense of already constituted organic matter which they absorb in causing in them special transformations—putrefaction, fermentation.

We find them everywhere in nature, and their power of wonderfully rapid reproduction by fission, and spore formation in many kinds, counterbalances their minuteness.

They exist in the ponds, creeks, rivers, lakes, the sea. They are on and in the surface soil and the manure heaps. They float accidentally in the air, and thence fall on infusions of vegetables, dead vegetable and animal bodies, fermentable juices, as cider, beer, wine. They attack the milk, cheese, butter, lard, meats and other foods.

They penetrate into the nasal cavities, the lungs, the intestines, and may enter the circulation and locate in the living tissues. Indeed, in the normal state, the skin, mouth, and intestinal excretions of man and beast, contain microbes innumerable. Through the mucous membranes, abrasions and natural ducts, some of them may invade the organism, and cause the most serious complications in the living machine.

Miquel, in making experiments to ascertain the relative quantity of germs in the air, found that there were 5,500 per cubic metre in the Rue de Rivoli; 11,000 in the operating room of the Hospital la Pitie, Paris. At an altitude of 2,000 metres there was none. After a rain the air was washed and comparatively free from microbes.

In water he found as follows: 248,000 per litre of rain water; 4,800,000 per litre of river water (water of the river Seine passing through Paris).

The proportion found in the air of the streets of Paris is startling and seems extremely high. Experiments made in other parts of the world have shown a much smaller quantity. Prudden, in his exceedingly interesting little book entitled, "Dust and its Dangers," records the average number of bacteria found in various parts of New York City as 376 per 10 litres (*i. e.*, in a volume about equal to a cube 8 inches square).

Carnelly found in the town of Dundee, Scotland, from 10 bacteria to 170 in ten litres of air.

It is self-evident that various atmospheric and telluric conditions will vary the quantity greatly. In dry, dusty weather the winds will raise a perfect shower of germs with the dust of the streets and roads, etc. This is particularly true when dry street sweeping is practiced. In rainy and snowy weather the germs will be brought to the earth in variable numbers. Again they are comparatively scarce in high altitudes.

In the water, it is needless to say, that surface water, shallow lakes and ponds, and the rivers receiving the city sewages and the draining of the shores, are more or less laden, according to the greater or smaller amount of nutritive organic matter that they contain,—being consequently far greater in the immediate neighborhood than at long distances from populous centers.

Indoors, the number of germs floating or deposited is comparatively greater than outdoors, particularly in houses imperfectly ventilated by chance apertures or chimneys. The number found floating in the air of a room depends on the stillness or stirring therein. For instance at midnight, when all has been still for hours, the minimum number is found, whilst in the morning, after making up the beds, for instance, causing the visible and invisible dusts to fly from the fabrics, clothes, furniture and floor, where they had sunk during the night, the number is incomparably greater. Then again there is a vast difference before and after sweeping.

Tucker, in testing the number of germs in the wards of the Boston City Hospital, found by the hourly examination from the still hour of midnight to late in the stirring hour of the day, 1 to 477 bacteria per 10 litres of air.

Carnelly found in clean houses 180 bacteria per 10 litres, and in dirty houses 900. In dirty schoolrooms with common ventilation the same writer found 2,000 living bacteria in the same volume of air, whilst in clean schoolrooms, mechanically ventilated, he found from 30 to 300.

Prudden exposed five minutes a dish of 3¾ inches in diameter, in a carpeted living room in New York, before sweeping, and found that 75 bacteria had settled onto the surface. He repeated the experiment when all was still, immediately after sweeping, and found 2,700 bacteria. It is needless to proceed further on this line, to point out the danger lurking from germ-laden air or water.

Yet, we must not think that all these germs are harmful. Indeed, comparatively few are, and even these do not always cause injury to animal life, because, in the first place, they do not always find in the animal bodies in or on which they settle means of ingress into the organism; in the second place, the tissues and liquids do not present always suitable nourishing media, particularly in the normal state; in the third place, the cells composing the higher organized beings are endowed with life, activity, energetic physical resistance, and being defended by the leucocytes, who seem to have the power of overcoming invading bacteria by phagocytism,* offer an effective barrier to the microbes; finally, the blood sėrum seems to be germicide.

But, on the other hand, there may be among the water and air bacteria, some so endowed and constituted, that their presence in the skin, in the mouth, the nasal cavities, the lungs, the intestinal tract, is a constant menace to health. And, to individuals presenting some pathological conditions, some germs are a positive danger. Note for instance the exposure of a man, suffering with a bronchial catarrh, to the dust of a hospital ward, or the dust of a bedroom containing tuberculous patients; note, again, the exposure of a wounded individual with a skin abrasion to the atmosphere of a badly ventilated, dirty house! In the former case tuberculosis may be the result, because the lungs present to the tubercle baccilli a proper, sticky nidus for their adherence, vegetation and multiplication, and the tissues of the body are perhaps weakened by the catarrhal affection. Healthy subjects, however, inhaling the same air, would likely suffer nothing thereby. In the second case, septicemia may occur, by the action in the wound, of germs always present in the intestinal tract, on the body and in the air, etc., but which succeed in overcoming the organism, only after gaining a footing in or through a weakened spot of the tissues, such for instance as are produced by cut wounds, or contused wounds with abrasion.

On the other hand, there may float accidentally in the air, or exist in water, a few extremely dangerous bacteria, such as the germs of Asiatic cholera, yellow fever, diphtheria, small-pox, glanders, charbon, which determine these special diseases, often in epidemic form, seemingly irrespective of the condition of health of the susceptible beings.

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* The leucocytes, white blood cells, are termed phagocytes because they are believed to absorb and digest bacteria.

FORM AND CLASSIFICATION OF SCHIZOMYCETES.—As we have already seen more than once, the schizomycetes are unicellular beings of a very minute kind, varied in appearance, ranging between one-ten-thousandth of a millimetre and a few thousandths of a millimetre. (Fig. 2.) Without attempting perhaps to classify them fully, Cohn has divided the bacteria, according to their shapes, into four groups :

First.—Spherobacteria, or the globular forms (commonly known as cocci).

Second.—Microbacteria, short rod forms (bacterium).

Third.—Desmobacteria, long rod forms (bacilli).

Fourth.—Spirobacteria, spiral forms.

This grouping might serve in a degree as a classification, but the forms are not constant during all the stages of microbic life.

Several authoritative naturalists have attempted to make satisfactory classifications, but none of these are free from objection, because of the still limited knowledge of a positive character, possessed by scientists, on the morphology of these infinitely small beings.

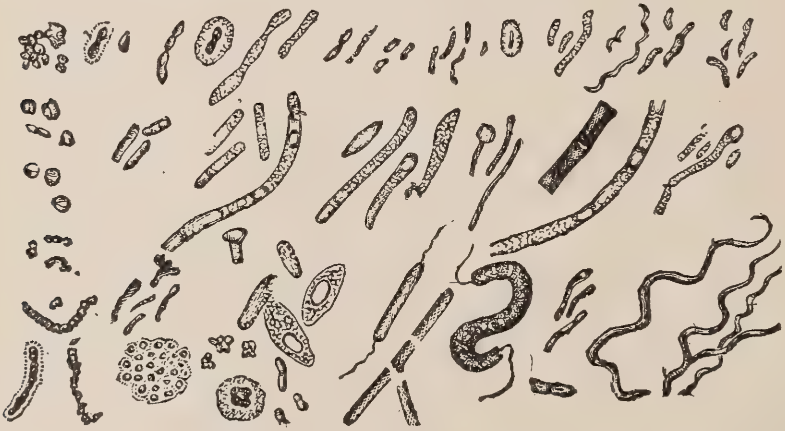

Figure 2. A variety of microbes showing the different forms constituting the basis of classifications. (Borrowed partly from Cornil and Babès.)

At the present writing, it appears that the following classes have the greatest number of followers. They were proposed by Van Tieghem in 1884, who places all the schizomycetes in the family of bacteriacees.

The class known under the name of :

Micrococcus, or *coccus,* is constituted by the individuals composed each of little round cells.

Bacterium, cylindrical cell.

Bacillus, cell of the rod shape.

Leptothrix, the indefinitely long filament without encasing sheath.

Crenothrix, the same kind of filament but provided with encasing sheath.

Cladothrix, sheathed filament with ramifications.

Vibrio, coiled filaments that may be dissociated.

Spirillum, long, spiral, screw-shaped filament (longer than vibrio).

Spirochœte, still longer spiral filament with numerous coils.

De Bary, from a more scientific basis, classifies the microbes called *bacterium* in the above, under the head of arthrobacterium and bacillus.

Now it often happens that the microbes of some of these species are grouped together in various ways. These special aggregations have been named by Van Tieghem as follows : The masses of cocci (zoogloea) united by a thick gelatinous substance are termed ascococcus ; adhering together, punctula ; when cylindrical cells (bacterium) are united by gelatine they take the name of ascobacteria ; without gelatine polybacteria ; united masses of rod forms or spirals are named myconostoc.

Another convenient classification is that of Winter and Flugge, which I give in tabulated form :

				GENERA.
Round or oval cells.	Isolated, in chaplets or in zoogloeæ			*Micrococcus.*
	Forming zoogloeæ in the form of	Solid colonies filled with cells.	In large numbers and irregular colonies	*Ascococcus.*
			In small definite numbers and regular groups	*Sarcina.*
		A single circular layer		*Clathrocystis.*

Cylindrical cells.	Short. isolated, in a mass or in zoogloeæ						*Bacterium.*
	Forming long filaments.	Isolated, interlaced or in bundles.	Not ramified.	Straight filaments.	Short, jointed		*Bacillus.*
					Long imperfectly jointed.	Slender	*Leptothrix.*
						Thick	*Beggiatoa.*
				Spiral filaments	Short, rigid		*Spirillum* (*Vibrio*).
					Long, flexible		*Spirochæte.*
			With false ramifications				*Streptothrix.* *Cladothrix.*
		In zoogloeæ					*Myconostoc.*

When the micrococci or cocci are two by two they are termed diplococci; when in strings or beads, streptococci. The cocci are about of the average of 0μ 2.* They are the smallest organisms that can be seen with our present optical instruments.

The various rod-shaped and spiral micro-organisms vary in length between 1 and 7 or 10μ and in thickness between 1 and 2μ.

VARIATION IN FORM.—The classification of the microbes rests, as we see, chiefly on the forms under which they present themselves, in the period accepted as the adult stage, but, as already mentioned, we must not infer that the shapes forming the basis of these classes are constant during the development and life of the microbes. On the contrary, certain microbes appear in diverse forms during their development, and the sizes, even, may be influenced by the nutritive surroundings. Fig. 3.

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* The μ, mikron, a unit in certain microscopic measurement, means micromillimetre, and is equal to one-thousandth of a millimetre. A millimetre is, as the word implies, the one-thousandth of a meter, and a meter is equal to 39.37 inches. A millimetre, then, is nearly 1–25 part of an inch and μ (mikron) is the 1–1000 part of 1–25 of an inch.

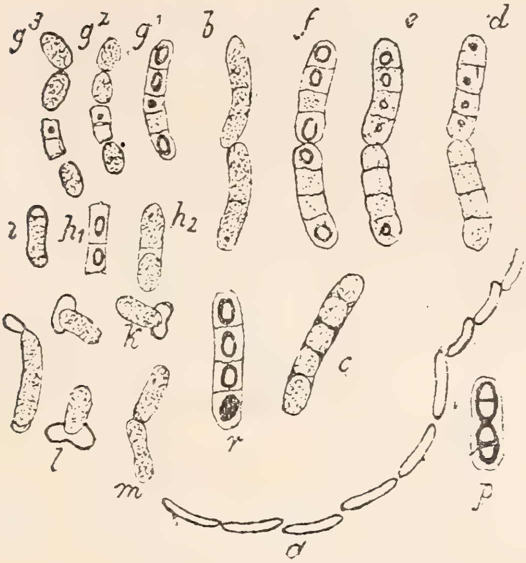


Figure 3. *Bacillus Magaterium*, showing various appearances during growth : *a*, outline of a motile chain of rods in active vegetation ; *b*, a pair of motile rods in active vegetation ; *p*, a quadricellular rod in a state of *b* after treatment with alcoholic solution of iodine ; *c*, a five-celled rod in the first preparation for forming spores ; *d*--*f*, successive stages of a pair of rods while forming spores ; *d*, about two o'clock in the afternoon, *e*, about one hour later, *f*, an hour later than *e*. The spores in formation in *f* are ripe towards evening ; no others were formed ; the one which apparently began to be formed in the third cell from the top in *d* and *e* has disappeared ; the cells in *f*, which did not contain spores, perished by about nine o'clock in the evening ; *r*, a quadricellular rod with ripe spores ; g^1, a five-celled rod with three ripe spores placed in a nutrient solution after several days' desiccation, half an hour after noon ; g^2, the same specimen at about half past one ; g^3, the same about four o'clock ; h^1, two spores with the walls of the mother-cells dried and then placed in a nutrient solution about forty-five minutes after eleven ; h^2, the same about half past twelve ; *i*, *k*, *l*, later stages of germination as explained in the text ; *m*, a rod formed from a spore placed eight hours before in the nutrient fluid and in the act of splitting transversely ; *a* mag. 250, the rest of the figures 600 times. (Borrowed from De Bary.)

GENERATION.—From this point of view, Van Tieghem divides the schizomycetes into *endosporous*, meaning those capable of reproduction by spore formation, and *arthrosporous*, those in which spores are not known to ever exist. The usual mode of reproduction, however, is by fission, that is to say, successive divisions or bi-partitions, each cell dividing into "two daughter cells through an unlimited number of generations." As a rule, the division occurs in one direction making the successive cells appear all in one row, as a long, segmented filament, providing that no serious interference has been interposed on the spot at the time of nutrition and growth. The microbes, in process of dividing thus in one direction, stretch out, a wall divides them in two, the extremities in contact become rounded and then the two parts separate. The diplococci and streptococci mentioned above are, doubtless, in most cases, germs thus joined together during the process of growth and segmentation.

In long spiral forms, the multiplication may occur by the segmentation of the whole into several short rods, each keeping in a measure a wavy appearance derived from the spiral shape which they gave to the organism before separation.

In the crenothrix, the reproduction occurs by both vertical and transverse segmentation at the terminal point of the filaments, that is to say, the cell divides at that part into four new cells, having first the appearance of little angular bodies, but the angles of which soon become blunt until the new beings are fully rounded. Then they grow into filaments if properly nourished.

In certain round cocci the division occurs in various directions.

In the sarcina, a class of microbes described in Winter, Radenhorst and Flugge's classification, division occurs in three ways through the organism, thus forming little cubical masses.

In some germs of the air, reproduction occurs by division within a large capsule. The sporogenous microbes belong chiefly, so far as now known, to the bacilli and a few other filamentous forms. Each cell usually generates but one spore, rarely two. Some authors have described bacteria throwing off numerous spores ; it is possible that in such cases the separating walls between the spores passed unnoticed.

The first thing noticed in the process of spore formation is the changes in the previously homogeneous protoplasm ; it gradually becomes darker, and even granular, sometimes giving the amyloid reaction. Soon a darker, minute body is seen within the envelope of the mother-cell; it acquires distinct contour, grows in size and reaches its largest volume in a few hours. This is the spore. It now is strongly refringent, of a colorless or slightly bluish, glistening appearance. At this time, the protoplasm of the mother-cell, which has been gradually utilized to make the spore, has about completely disappeared from around it, its envelope may break to liberate the new body, or it remains, for a while, apparently as a disintegrated shell around the glistening mass.

The size of spores varies between $0\mu1$ and $0\mu6$. Shape, spherical or oblong.

STRUCTURE AND CONTENTS.—The schizomycetes all have a surrounding wall or membrane and contain a protoplasm. The analyses of Nencki show the chemical composition of both the membrane and content to be, usually, a special albumenoid substance named mycoprotein. However, there may be some other chemical agents entering into it. It seems certain that the envelope contains in certain cases some cellulose. Certain bacteria contain no mycoprotein but are constituted by other chemical matters resembling in some cases the caseine of plants and the mucous matter of animals.

There is a tendency, in the envelope of several microbes, to form gelatine or to become gelatinous itself. In such cases we sometimes find a number of them imbedded in gelatinous masses (zoogloea, etc.), or if the gelatine is thrown around individual germs, as in the diplococci of pneumonia, they become encapsuled. The membrane is sometimes naturally colored yellow, red or blue.

The homogeneous protoplasm of the cell is more refringent than water. It sometimes contains small specks or granules which perhaps are of a fatty character; vacuoles (or empty spaces) are exceedingly rare. Iodine stains the protoplasm yellow.

Both the envelope and protoplasm have a marked resistance to bases and acids which destroy animal cells. Some authors have seen in this an indication pointing to the vegetable character of bacteria.

It is also on this resistance to reagents, and the germ's affinity for aniline dyes, that the coloring methods of bacteriology are based. Iodine reagents, by the blue color that resulted in the protoplasm of certain microbic cells, made possible the discovery of amyloid substances.

MOTILITY.—Certain schizomycetes are endowed with the power of moving and others are not. This property is due to vibratile cilia at the extremities of the bacteria, the filamentous forms having two to six whilst, according to Zopf, the round germs have only one. Only Ehrenberg and Cohn seem to have positively identified cilia in the cocoid forms. On account of their constant motion, and of their refringence being so near that of water, it is extremely difficult to observe the cilia of the fine germs of this character.

The non-motile germs have no cilia. Certain bacteria grow cilia only in case of necessity, such as when they proceed from the bottom of a liquid to the surface for the purpose of nourishment.

The movements of bacteria are very interesting and rapid, and should not be confounded with the well-known brownien movement. The movements of motile microbes are incessant and in all directions, whilst the molecular brownien movement which is often present also in certain bacteria, particularly the spherical forms, is a characteristic trembling, or whirling, on the spot, that the eye soon learns to diagnose. These motions are, perhaps, due to the shape and composition.

[Lesson third in March number.]

SPECIAL TRANSLATIONS FROM THE GERMAN.

[BY H. W. LOEB, A. M., M. D., ST. LOUIS, MO.]

THE ROMAN MALARIAL FEVER, ESPECIALLY IN SUMMER AND AUTUMN.

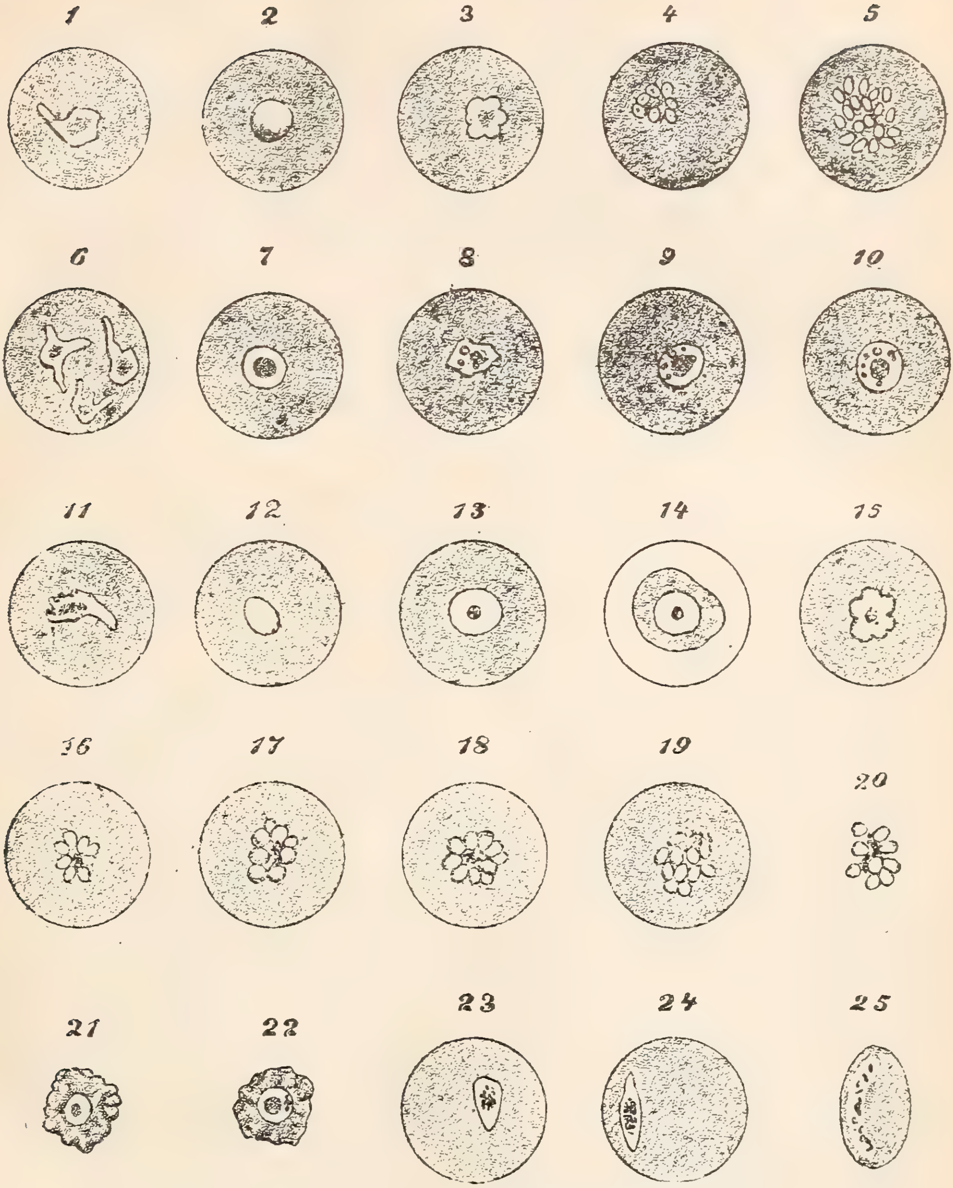
By A. Celli and E. Marchiafava,

Of Rome, Italy, in the *Berliner Klinische Wochenschrift,* Nov. 3, 1890.

In order to obtain a proper understanding of the before-mentioned change of the blood by malarial infection, one must make, as we indicated some time ago, a large number of observations upon the severer and milder cases of malaria, both during the stage of apyrexia and the febrile stage.

It is well known that malarial infection is produced by a specific parasite, which wanders into the red blood cells in which and upon which it lives and develops, changing further the hæmoglobin into melanin and which multiplies by division. Besides, Golgi, who studied malarial fever at Pavia, has shown the connection between the different phases of the development of this same parasite and the course of the fever curve. He also discovered that the parasite of the quartan and of the tertian varieties differed both morphologically and biologically. We have busied ourselves with the summer and fall malarial fever of Rome, and we can state that in these the small amœboid parasite exclusively is found.

The profession knows that the malarial fever of summer and fall has a character entirely different from that of spring. The latter form has constantly a distinct cyclical course (quotidian, tertian, etc.), is never pernicious, recovers of itself generally without quinine, and is always cured by quinine. On the contrary the fever of summer and fall is not cyclical. The attack occurs in the last-named form of malaria, as a rule, daily, and lasts, frequently, with trifling fluctuations of temperature, twenty-four, thirty-six or more hours so that fever and apyrexia imperceptibly merge into one another. In these cases when the initial chill is missing, the apyrexia is of shorter duration and the headache and malaise persist for a long time; the patients offer no clear distinction with reference to the type of fever, and they maintain what now and then corresponds to the truth—that they have been attacked by a continued fever. These are the severe pernicious cases which seem preferably to attack the central nervous system. They never recover spontaneously, and quinine does not operate so certainly as in the milder cases. The frequent relapses are characteristic, as also severe attacks which occur as a sequence. Finally to these belong those cases of pernicious fever with trifling elevation of temperature, even with subnormal temperature. In these cases, as we have published in a former article, the regular so-called small plasmodia (Piccoli plasmodi) occur. The red corpuscles contain at the time of the acme of the fever one or more living, moving parasites. The form is the same in the sweating stage and in the begining of the apyrexia.



EXPLANATION OF THE DIAGRAMMATIC DRAWINGS.

Figures 1–6. Circular form of the small pigmented plasmodium. In figures 4 and 5, the sporulation is ended and no pigment appears.

Figures 7–20. Circular form of the small pigmented plasmodium.

Figure 7. Ring-form with a hæmoglobin bud in the middle. (*Hämoglobinauge.*)

Figures 8–9. The hæmoglobin bud is broken up in more divisions.

Figure 10. Pigment form from the decomposed hæmoglobin bud. (See 7–9.)

Figures 11–12. Amœboid and non-moving form with its pigment.

Figures 13–14. Motionless parasite with pigment in the center. In 14 the hæmoglobin has encircled the parasite.

Figures 15–20. Spore formation. In 15, the beginning. In 20 the pigment is surrounded by free spores.

Figures 21–22. Atrophic red blood cells with plasmodia.

Figures 23–25. Young crescentic bodies—Laveran's parasites.

However the plasmodia show, some hours before the attack, a certain change so that one can prophesy the onset of an attack by the observation of the blood.

Before the attack one may observe:

First. Round, motionless, small distinct bodies which contain in the center a hæmoglobin flake or pigment grain. (The ring-shaped form.) Fig. 7–10.

Second. Amœboid also small, but more or less moving organisms with an indented contour and of a grayish white color. They contain the smallest pigment grains, visible only with the greatest care. Fig. 11–12.

Third. Large, round, motionless, white parasites with pigment flakes situated in the center or at the periphery. The still remaining hæmoglobin lies in concentric layers around the plasmodium while the edges of the red blood cells have become paler. Fig. 13–14.

All of these circular forms which we have just sketched, but especially figures 21 and 22 of the above drawings occur at the end of the apyrexia and in the beginning of the fever attack. And indeed the parasites are found in the red blood cells, which have diminished one-third in size, are irregular, and which have the color of brass. After the entrance of the parasite the atrophied blood corpuscle is very easily, by a little practice, discriminated from such forms, which one observes under the microscope, in the decomposition of the blood. In the pernicious cases the parasites are seldom in the stage of sporulation, while they occur frequently in the quartan and tertian form, and especially in the beginning of the attack. These spore-carrying parasites occur exclusively in the red blood cells. However, only a portion of the latter remains, in the middle of which is visible a pigment flake, and more seldom a living, moving parasite or some pigment crystals. Fig. 15–20.

Unpigmented plasmodia in the state of sporulation are formed only rarely in the blood taken by puncturing the finger, but are very numerous in the brain-capillaries, especially in pernicious fever. In the beginning of the paroxysm of fever, and for some hours succeeding, the unpigmented amœboid forms only occur.

In distinction from the parasites of tertian and quartan fevers, which the eminent Golgi has studied, the plasmodia of the fall and winter fever of Rome can remain living and moving, for a long time, free of pigment. When the motion ceases, they take on the ring-form. Then they contain hæmoglobin flakes which in the form of a wreath enclose the center. This is the stage of sporulation ; spore formation, however, only takes place within the red blood cells. When this occurs the blood cell is soon destroyed. The inquiry upon this problematical stage of sporulation seems of special interest. In this, we do not, by examination of the blood of the skin, obtain sufficient explanation ; we must search the blood of the inner organs, in life as well as after death. In this way we meet the curious fact that spore-carrying parasites may disappear for some time from the finger blood, while they are present in the blood of the spleen, obtained by aspiration during life. So it may happen that spore-carrying plasmodia may disappear from the living blood, while they are plentifully found in the blood of the inner organs especially in the brain.

This opposes the objection that in these cases the development of the surviving parasites continues after the death of the host, because the blood of the veins of the arms, taken during the autopsy, is found free from spore-carrying parasites, while, in the blood of the brain, pigment and spore-carrying parasites occur in large quantities. Hence it follows that in the tertian and quartan fevers the entire development cycle of the parasites is visible in the blood of the finger, while in the autumn fever of Rome all of the development stages do not appear in the same blood. Whereas spore-carrying parasites are not generally found in the finger blood, it is however easy to foretell the approach of the fever paroxysm by examination of the blood. If the pigmented plasmodia here described are found, it can be foretold for the next few hours with all certainty. Our information hitherto may be reduced in the following way :

The parasite of summer and autumn fever runs through its entire course in a very short time. It may appear with this spore formation and without pigment formation. The quotidian and fever forms with short apyrexia agree in this. In these, too, the process of development from the amœboid to spore-carrying plasmodium is completed in twenty-four hours; yes, in a shorter time. In these cases the spore formation may occur so quickly in the inner organs that the colony breaks down into daughter cells before they are carried in the blood-stream to the blood of the hand, The blood of the finger will then thoroughly show spore-carrying parasites only when they are formed in very great quantities.

In conformity with this view, the splenic blood obtain by aspiration in a case of pernicious fever contained:

First. Amœboid unpigmented forms, as in the finger blood.

Second. Non-moving plasmodia which are found in the red corpuscles and especially in degenerated ones (this form was rare in the finger blood).

Third. Large, white, unpigmented cells.

Fourth. White cells, some irregular dark-colored flakes which the red and white cells contained.

Fifth. Round transparent cells of various size, with black quickly-moving contents.

Sixth. Round plasmodia within the red blood cell with a pigment flake in the center.

Seventh. Spore-carrying parasites in the interior of the red blood cell.

The small amœboid forms generally disappear from the blood upon the administration of quinine. In some cases, however, two or three attacks occurred before a complete cure even when large doses of quinine *per os* or subcutaneously were given.

LAVERAN'S CRESCENT-FORMED PARASITE.

We have observed the crescent-formed parasites, discovered by Leveran, since 1885, and considered them a peculiar grade of development of the plasmodia. Celli and Guarneri showed later (*Riforma Medica,* 1888) that the plasmodia of malaria may run through two different phases of development. They appear first as the amœboid form, and later as sickle-shaped bodies. The latter recall the gregaria and the coccidia which Metschnikoff calls the parasites of malaria. Grassi and

Seletti name the amœboid form hæmamœba and the crescent-shaped, leverania. The crescent-shaped are exceedingly polymorphous and they likewise enter the red blood cells and there go through their cycle of development. Most of the remaining red blood cells which have been attacked by the parasite are clearly visible, while in other cases the round spores alone remain. Sometimes the blood cells become quickly pale, and only their margin still preserves the original color. In some cases the crescentic parasite presents the same color as the blood cell. A double-folded membrane which is not always clearly visible surrounds the plasmodium, its contents being equally hyalin. The poles stand out clearly, by coloring the granular contents, in which a nucleus is visible. The latter is occasionally visible in the uncolored specimen. The pigment is equally well deposited over the crescent (Fig. 25) but sometimes it is massed in a circle or with irregularity. It is generally motionless but it is also found in the round and flagellated forms in active motion, which is generally limited to the vicinity of the nucleus. Once we saw an unpigmented flagellated parasite.

The crescent-shaped and spindle-form parasites may change into the oval and circular forms. The former breaks into round yellowish cells of the same or different sizes. This occurrence has only an external resemblance to sporulation. While the spores which one may observe in the spleen-pulp and marrow of bones remain for several days unchanged, the crescentic parasites are rapidly destroyed so that at most for a short time is its pigment store discoverable. By the use of dilute mineral acids, organic acids and dilute alkalies, the crescentic bodies are just as quickly destroyed as the other malarial parasites.

Laveran has discovered the crescentic bodies in all forms of malaria. He thinks, however, that they are found by observation more frequently in the severe return forms than in the fresh cases.

We have seldom seen these parasites in the summer cases but most frequently in pernicious and cachectic cases, especially in autumn. Again, we have found them in cases which were not yet treated with quinine, during the attack of fever but continually coincident with the unpigmented amœboid forms. We have further seen parasites which would indicate a transition form between the crescentic bodies and the amœboid plasmodia. We are inclined to consider the crescentic parasite as a later stage of development of the amœboid forms, as we have regularly seen the latter in all cases during the fever while the former even in the severe cases may disappear for a time from the blood. These results are obtained from researches upon the living blood in the skin, lungs and spleen.

Case 1.—In a case of summer malaria of the quotidian type the aspirated blood of the spleen, before the fever paroxysm contained amœboid and round pigmented forms and yet not so plentifully as the finger blood. Near by were the parasites of spring malaria and the spore-carrying forms in small quantities and in larger quantities the brass-colored and white forms with blood corpuscles filled with melanin grains.

Case 2.—In a second case with exceedingly infrequent paroxysms, the blood of the spleen and lungs contained during the apyrexia the crescentic forms, and during the attack the small amœboid forms. The blood of the finger exhibited the same appearance, only in the latter there was found less black pigment than in the blood of the inner organs.

Case 3.—Sixth return, cachexia. The blood of the finger and of the spleen contained during the paroxysms only the small amœboid forms. Quinine was then administered. The fever diminished. Now we found the crescentic bodies.

Case 4.—Malaria existed for four months. Several relapses undergone. In the blood of the finger isolated amœboid and a few crescentic bodies. The same found in the spleen blood, also more numerous pigment-containing and unpigmented white blood cells. Besides this, parasites with pigment in the center, prepared to form spores.

Case 5.—In the blood of the finger, numerous amœboid forms, a few of which in the state of sporulation; numerous crescentic bodies. In the spleen blood spore-carrying plasmodia, a few crescentic bodies.

Cases 6 and 7.—The living blood contained few crescent-shaped and many amœboid bodies. In the blood of the organs were found many crescentic and few amœboid forms.

In conformity with Councilman the crescentic and these metamorphosed bodies were found in greater number in the spleen. This difference is not found in the other cases because the different forms of the parasites in the various, simultaneous, blood examinations are almost uniformly distributed.

The sections sent by Dr. Bignami give the same result. In pernicious fever the blood of the spleen and marrow of bones contained very numerous crescentic parasites but these are free of spores. In opposition to this numerous spore-carrying forms are found in the brain and lung capillaries. In support of the derivation of the amœboid forms from the crescentic bodies, we have the inoculation experiment carried on by Gualdi and Antolisei. The inoculated blood contains only the crescentic bodies. The amœboid forms alone, however, are observed in the blood of the inoculated patients at the beginning of the fever. However, if the amœboid forms have been before observed in the blood of the patient who has been inoculated, and if they appear two days after the inoculation, the experiment presents no full evidence. It must be repeated with far more stringent cautions.

A further proof of the derivation of the crescentic bodies from the amœboid form lies in this that the former appears during the apyrexia and the latter during the fever. Of course this conclusion can only be supported by experimentation with a constantly small quantity of blood. Leveran's and our own observation show that the crescentic bodies occur in the most varied fever types, that they are found simultaneously with the oval, round and spore-carrying forms during the fever unless quinine has been administered. We saw these parasites—in conformity with Laveran—very often after repeated attacks and in the long-lasting fever heretofore called anæmia. We have also seen cases of pernicious fever without the crescentic bodies, some, too, in which the parasites appeared first before the symptoms of pernicious fever had declined.

All our observations indicate that the cases of malarial fever which occur in Rome during some years, especially in summer and autumn, are characterized by a tendency to become pernicious on account of the daily repeated attacks; that in these cases the small amœboid parasites occur in the blood-corpuscles. These plasmodia have either a short development and are then unpigmented or they have a longer one when they contain pigment. The same thing occurs, according to Golgi in the tertian, quartan and mixed forms. These parasites are found only in certain neighborhoods and in the light forms of malaria. Different malarial parasites correspond to the different seasons, the different malarial localities, and finally to the mild or severe forms of fever.

WHAT MEASURES ARE DEMANDED AGAINST THE SPREAD OF DIPHTHERIA.

Prof. F. Loeffler, of Greifswald, thus concluded his paper upon the above subject (*Berliner Klinische Wochenschrift,* October 6, 1890) read before the Tenth International Congress at Berlin:

First. The cause of diphtheria is the bacillus diphthericus. It is found in the exudation from the diseased mucous membrane.

Second. With the exudation is the bacillus scattered externally. It can be deposited upon everything which is in the vicinity of the patient.

Third. Those who have diphtheria harbor these infection-producing bacilli as long as the slightest trace of the condition remains, and also some days after the disappearance of the disease.

Fourth. Diphtheria patients should be isolated so long as they still possess bacilli in their secretions. Children who have had diphtheria should be kept from school at least four weeks.

Fifth. The bacillus diphtheriæ lives in the little pieces of membrane in a dry state for four or five months. It is, therefore, necessary that everything which can come in contact with the discharges of the diphtheritic patients, the wash, bedclothing, drinking and eating utensils, attendants' clothes, etc., should be disinfected by boiling in water or by treating with steam at a temperature of 100° C. (212° F.).

Further, the room in which the patient has been lying should be carefully disinfected. The floor should be repeatedly scoured with a warm, sublimate solution (1 to 1000), and the walls and pieces of furniture thoroughly rubbed.

Sixth. The researches upon the vitality of the diphtheria bacillus in the moist state are not yet completed. The bacilli are, if possible, longer viable under a moist condition than in the dry state. Moist, dark dwellings seem, indeed, to be propitious for the preservation of the diphtheritic virus. Such dwellings should, therefore, be made hygienic; especially is it necessary to care for the thorough drying of such places and for the entrance of light and air. It is especially necessary to observe caution in a change of residence that there has been a thorough disinfection of the formerly infected dwelling.

Seventh. The diphtheria bacillus thrives outside of the body at a temperature of 20° C. (68° F.). They grow very well in milk. It is, therefore, proper to oversee the milk business. The selling of milk from a farm-house in which diphtheria patients exist should be forbidden.

Eighth. The diphtheria-resembling diseases of numerous animal species, of pigeons, chickens, calves, hogs, are not contracted from the bacillus of human diphtheria. The diphtheritic animal diseases are, therefore, not to be feared as a source of diphtheria.

Ninth. The statements of Klein in regard to the etiological identity of the disease in cats, as observed by him, with human diphtheria are not yet certain and need wider investigation.

Tenth. Lesions of the mucous membrane favor the fixation of the diphtheritic virus. Susceptible individuals, however, can become diseased without existing lesions.

Eleventh. During the time in which diphtheria prevails, the cleanliness of the mouth, nose and throat of children should receive special care. Moreover, it seems advisable that the children should be instructed to use prophylactic mouth-washes and gargles with aromatic waters or weak solutions of corrosive sublimate (1 to 10000).

Twelfth. The favorable influence of certain meteorological factors upon the spread of diphtheria is as yet not with positiveness known.

THE PATHOGENESIS OF TETANUS.

Faber and Knud, in the *Berliner Klinische Wochenschrift*, have succeeded in obtaining a filtrate, completely devoid of bacteria, from a strong, virulent tetanus-culture, which, inoculated into animals, reproduces positively the known symptoms of experimental tetanus. The poison operates after a certain period of incubation, which depends on the virulence and quantity of the filtrate. It acts by inoculation into the tissues, and also by intravenous injections; but while in the former both local and general convulsions occur, in the latter the local convulsions do not appear. No immunity is obtained by the filtrate. Heating the solution for five minutes to 65 degrees causes every trace of the poison to disappear.—*Centralb. fur Bakt. und Parasit, Dec.* 4, 1890.

SPECIAL TRANSLATIONS FROM THE FRENCH.

THE FILTRATION OF WATER.

BY N. E. DUCLAUX.

The study of microbes has completely transformed the idea that we had formerly on filtration. We asked, until of late years, that a filter only free the water of its matters in suspension, to render it clear when it is cloudy or even only shaded, and every filter that accomplished this was declared good. We have asked, besides, afterwards, that filtration deprive the water of some of its elements in solution, for instance, the organic matters which give it a taste, and may render it impotable. All the filters do not give this result. The filters of charcoal are more apt to do so than others, and they have had their day. At present, what we fear the most in water are the germs of disease that it may contain, germs so exceedingly small that they pass through all usual filters. All at once, all these filters lost their popularity, and it has been necessary to find new types capable of attaining the object desired.

I am not here to describe them ; they are known enough. It is sufficient to say that they have solved the problem, and that water which has passed through a good (improved, modern)* filter is absolutely free of microbes, whether it is acid or alkaline,pure or charged with organic matter. Unfortunately, to obtain these results, very fine porous porcelains, through which filtration is slow, are necessary. We may, in augmenting progressively the filtering surfaces, supply with sterilized water a home, a school, barracks, perhaps also a city, though this last result has not yet been realized ; but we can think to render thus harmless only drinking water. As to the water of general service it is, with the wants of modern hygiene, of too great a volume to be sterilized by these methods.

Still it is important to render them as harmless as possible, for two principal reasons. The first is, that, if it contains pernicious germs, some of these may be left on utensils or the clothes washed, on the floors, and in the streets sprinkled. The second is, that, in the cities where there is not absolutely separate ducts for drinking water and washing water, when, in case of scarcity of the former, may rise the temptation to replace it temporarily by the second, this temptation becomes irresistible if there is, to realize it, only to turn the key or manipulate a faucet. And it suffices that impure water penetrate but a moment in the pure-water ducts or pipes to deposit therein germs, on the ultimate evolution of which we know nothing, if not that, *a priori*, they have a chance in two to become dreadful.

The problem of water for alimentation has been solved in various ways. Certain cities, as Paris, which have succeeded in procuring drinking water of excellent quality, depend on this, and do not think of their other waters, which they receive directly from a river, and which they send, without previous filtration, in the pipes, and sometimes in some pipes which should never receive anything but potable water. Other cities, less privileged, from a point of view of drinkable water, filter indistinctively all their waters, either by building laterally to their rivers certain forms of filtration dams, as Lyons and

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* The editor.

Toulouse, or in making the water pass on artificial filters, as Berlin and Zurich. The two extremes of these solutions exist for Paris, on one side, in maintaining, during eleven months of the year, security against the diseases that water may convey, and promenading, during the last months of the year, the sprinkler of epidemic diseases in various quarters of the city, in order to create no jealousy ; on the other hand, Berlin, for example, in supplying, the whole year, to her inhabitants, mediumly good but not warranted water, but which they endeavor to render as pure as possible. It would be very difficult to know, and, so far as that goes, useless to seek, which of these two systems is the best. They are both bad ; they must be regarded as makeshifts, and we must seek to improve them. From this point of view, there has been made at Berlin and Zurich, on the use of industrial filters, curious observations which renew all that we thought we did know on filtration, and the interest of which is too great not to be given space in these *Annales*.

The great industrial filters are, as we know, sand filters formed of a lower layer of washed pebbles, then a layer of gravel, then superposed layers of sand, finer and finer. To wet them regularly, the water is allowed to penetrate it slowly from the lower layer. When, in rising, the water has pushed before itself the air contained in the interstices of the sand, it is allowed to penetrate the filter from the top layer, and it filters under pressure from top to bottom.

After numerous tests, the superiority of sand as filtering matter has been recognized, and when possible diluvial sand, principally the quartzy kind, containing the least possible proportion of carbonate of lime. This sand is in irregular grains, more or less fine, and, in noting that it filters properly only when it has attained a certain degree of tenuity, you might think that it is closely related to the constitution of porous porcelain, and that its mode of action is probably the same. If it were thus, its history need not be written, but, in reflecting a little, we see that it cannot be.

In the first place, from a point of view of the attraction that the walls of a filter exercise on the minute solid bodies in suspension in the water, we know, by the tests of Mr. Kruger, that sand is not worth the raw or cooked clay. Yet experience has taught the preference of the sand filters. It is true that they are filters of fine sand; but, as the sand augments in fineness, the total volume of the empty spaces, left free between the grains, does not diminish as much as we might think. If the sand was entirely formed of grains of equal size and perfectly spherical, we could fill completely the space that it occupies in supposing each grain replaced by a cube, the side of which would be equal to its diameter, and the proportion of the empty spaces to the total volume would be equal to the proportion of the sum of the volumes of the cubes which would not fill the sphere which they contain. Now, a sphere placed in a cube, the height of which is equal to its diameter, fills, as we know, about half of the volume; the proportion from the hollow to the full is then the unit, and the proportion from the hollow to the total volume is of about one-half. The size of the spherical grains may, therefore, decrease indefinitely; if they remain equal, there will be always, theoretically, 500 litres of space per cubic metre. In practice, the existence of smaller grains, which lodge between the large ones, diminishes this volume a little, but it is curious to see that the proportion of the empty space to the total volume remains about constant as is sustained by the theory. In five kinds of finer and finer sand, studied from this point of view by Mr. Piefke, it has varied only from 29 to 34 per cent., and, in a general manner we may admit, that, in the sandy, filtering mass, there is about one-third of space occupied by the air when it is dry, by the water when it is in operation as filter. Of what use, then, is the sand if it does not diminish the total volume of the spaces? It augments the number of lacunary spaces, and consequently their total surface, and the mean proximity of the walls which limit them; thence arise two advantages: one of a purely physical order, the other of intermediary order in physics and chemistry.

The first advantage is to render uniform and regular the liquid current which passes through the filter. The moving power, represented by the pressure of water weighing on the top of the filter, meets a resistance, which, as experience has proven, is in proportion at the same time to the thickness of the filter if the filter is homogeneous, and to the rapidity of the liquid in the lacunary spaces, every time that this rapidity is not too great. When these lacunary spaces are irregular, water does not run through at a constant rate. But the law remains true for the mean rate. This is what Darcy had perceived, without demonstrating it with precision. I have made this demonstration for the porous walls, and Mr. Brunhes for the filtering masses of gravel. We can, therefore, say, basing ourselves on the experience, the equation

$$v e = m h$$

where h represents the pressure of water on the upper part of the filter, v the mean speed in the filter, and e its thickness. We express in this way that there is equality, that this equilibrium between the power and the resistance, and that the movement of water is uniform with the speed v the value of which is

$$v = m \frac{h}{e}$$

To have an idea of what is the factor m introduced in the equality, we must suppose $h = 1$, and $d = 1$; that is to say, to represent to one's mind a filter of equal thickness for instance to 1 metre, operating under the pressure of 1 metre of water: we would have then $v = m$, which is the same as saying that m is, in metres, the swiftness of the current of water passing through the filter. This swiftness being evidently the slower in proportion as the filter is made up of finer sand, m diminishes with the coarseness of the elements of the filter, and even much faster than they. It is impossible to give the law of variation when the lacunary spaces are irregular, but m varies as the fourth power of the diameter in capillary tubes. The diminution is, therefore, rapid when the diameter diminishes.

Fine sand insures us, beneath an average thickness, the slow circulation of the liquid which passes through it, and by that the regularity of the action of the lacunary walls on the water of the filter. This action, on which we have often insisted in these *Annales* is a molecular action being exercised at a distance on the solid bodies in suspension, and immobilizing them in contact with the wall by the same mechanism that fixes a coloring matter to the surface or in the structure of the fibres of a tissue. It is here that we find the inferiority, already mentioned from is point of view, of a wall of silicious sand on the wall of y, and as, besides, our lacunary spaces are certainly very egular we have the right to doubt, *a priori*, that this filter erates as a filter of porcelain, and arrests all the microbes in spension in the water which runs through it.

To know this, we have only to repeat an interesting experient of Mr. Piefke, who after having filled with sterilized nd a filter, the walls of which had been washed with a solun of corrosive sublimate, and after having besides taken the ecaution to leave the whole during twenty-four hours in conct with a solution of sublimate, evacuated the antiseptic uid, and caused his filter to operate in the ordinary fashion, counting the number of colonies (of microbes) as furnished each cubic centimetre of water before and after filtration.

Instead of diminution in the number of microbes, it is an gmentation that he has noticed, at least in the first days. oreover, not only was the water sterilized in this contrary shion (that is, not sterilized at all) but, from the point of ew of limpidity, the filtration was most imperfect. Little by tle the filter became obstructed. The exit of water under a ven load diminished, and it was necessary to augment the essure to obtain this exit at the same level. Little by little, so, there was formed on the superior surface of sand grayish ucous layers, formed of a net work of filaments of algæ, icrobes, diatomes, the whole imbedding the sedimentary, ineral and organic matters that any water usually contains. s this surface living layer became thicker the filter operated tter, the water was more limpid and contained less microbes. it it is scarcely before the period of two months that this filter ve acceptable results, that is, that the number of bacteria in e filtered water was reduced to a few dozen per cubic centietre.

The ordinary filters, made with diluvian sand, simply ished and populated of microbes, arrived more rapidly at the rviceable state which is characterized by the term *ripe.* But ey passed through the same phases : at the origin, they filtered dly, and it is only when the surface was covered by this uddy coating which we have just mentioned, that the number bacteria in water filtering through it is reduced to its inimum.

We arrive, therefore, at this apparently paradoxical conclusion, that it is the bacterial surface coating of the filter, and not the sand which fills it, which retains the bacteria of water. In reflecting on this the subject is not so astonishing. When we filter an acid precipitate of sulphate of baryta on filter paper, the liquor that passes through is at first cloudy, and it is only after this sulphate precipitate has itself lined the bottom of the filter that the same sulphate is completely retained, and that the liquid is clear. This coating of entangled bacterial filaments is thus much less permeable than sand. What proves it is that it is necessary to augment the pressure in proportion that this coating thickens, in order to keep the filter in a condition to render its ordinary supply, and it is doubtless this coating which opposes itself to the passage and reduces the value of the coefficient m in the formula above given ; for, when we lift it up, the sandy layers regain at once their old permeability. We understand very well, therefore, that this upper coating ends in forming a filtering wall as soon as it has covered the surface ; it is a living filter, instead of being a mineral one.

But this conclusion, in its turn, raises a number of questions to which we have yet no answer. If the sand serves only as support to the true filter, why has experience taught us to give it this thickness, which is, at the minimum, with the fine sand, of 60 centimetres. This thickness of sand is traversed by the microbes,for they are always to be found in the dripping filtered water. They may even swarm there and multiply, as demonstrated in the experiments of Mr. Piefke, which we cited a while ago. How is it that they do not fill the filter completely ? Finally, whence comes this continual exit of bacteria with the water that comes from the filter ? Does it come from the surface, or from the depth of the filter ? To solve these questions we must study the composition of a ripe filter at the moment of its most perfect operation. In the beginning, this filter was formed of homogeneous sand, not washed ; the microbes were equally distributed throughout its whole thickness. When it is ripe a new study shows that the microbes have augmented in number, but unequally in various layers. At the bottom of the filter the multiplication has been poor, but the populating is more and more abundant as we ascend towards the surface, and, on the surface itself, the number of germs per cubic centimetre is very great in comparison to what we find in a cubic centimetre of sand from the lower layer.

We understand without trouble that experience should have taught to modify the speed of the current of water through a filter thus constituted. The sand, a nonporous matter, is not penetrated by the microbes, and serves as support for them ; but a current a little rapid would sweep them away, and does in fact sweep them away. We must, therefore, cause the filter to operate under light pressure, and not exact from it a quantity of water beyond a certain supply. The filters of Berlin scarcely surpass the limit of 100 millimetres per hour. A more rapid current would force the impurities that cover the surface to penetrate deeper in the thickness of the filter, would augment by that means the resistance and reduce the supply. On the other hand, it would carry in larger proportion the microbes and nutritive organic matters that water contains.

It is true that these organic matters are in small quantity, and at first there seems to be an enormous disproportion between the weight of the alimentary matter and the number of beings struggling for it. A litre of water from the Spree, for instance, contains about 80 milligrams of organic matter, in counting as such, all that which in the evaporative residue of one litre disappears when calcinated at a mild heat, and without decomposing the carbonates. On the other hand, we find often in it 100,000 germs per cubic centimetre, that is, 100,000,000 per litre. But these 100,000,000 of germs, in supposing each to be 1-1000 of a millimetre, and attributing to them the density of water, do not weigh 1–10 of a milligram, which comes to saying that the weight of the nutritive matter is about 800 times the weight of the living beings that may consume it.

This nutritive matter, therefore, is not wanting in quantity, but perhaps we would be less satisfied if we analyzed it as to quality. From this point of view we have only incomplete information on the subject, due to the studies that we will resume further. But if we ask ourselves, *a priori*, whence come particularly the organic matters that we may find in water, the general notions that we have on the organic economy of the world will answer that they are formed chiefly of the product of microbic life.

Vegetables and animals have for property to render insoluble in water the substances of which they nourish themselves, and all that which they reject that is soluble in water, for instance in the urine of animals, is formed either of inutilizable products or products used by the cellular life. It is after they are dead that microbes render soluble in water, either by their diastases, or their vital action, the materials of superior beings. Hardly are they dissolved, that other microbes seize upon them. And, in a word, the organic materials in solution in water must be formed, if not totally, at least in a large proportion, of substances having undergone in a more or less pronounced manner the action of cellular life or that of microbic life, and have become by that means less proper to nourish new beings. We will soon have occasion to give importance to this conclusion.

It would be very useful to report this conclusion directly by experiment. Unfortunately organic matter of water has never been studied except by so-called practical means which, invented in England for a pressing need, have become implanted we know not why in science, and enjoy a reputation that we cannot explain. I mean the quantitative analysis of the organic matter by the hypermanganate potash in acid or alkaline solution, and in general all those processes in which, instead of determining by weight the total quantity of organic matter contained in a given water, it is attempted to analyze it indirectly, such as for instance, by the quantity of oxygen which it needs to burn.

When organic matter is heterogeneous, as necessarily is that which is in solution in the water, we cannot establish its weight from the oxygen necessary to burn it ; for its different elements need for complete combustion different proportions of oxygen. The sugar, for instance, needs about its weight, the alcohol the double of its weight. We could therefore conclude nothing from the total quantity of oxygen liberated by a given weight of hypermanganate of potash, even though this hypermanganate of potash would push to the very bottom the oxidation of organic matter on which it is made to act. As to the already old experiments of Messrs. Tiemann and Preusse, there is not a substance, except oxalic acid, that can borrow from hypermanganate of potash all the oxygen it needs to burn, and they would even borrow from it very different fractions: Tartaric acid, 4–5; sugarcane and glucose, 1–2; tyrosine, 1- 3; asparagine, 1–9; leucine, 1–10; benzoic acid and allantoine, 1–40; urea, none at all. We may add to this cause of uncertainty, resulting from the fact that the weight of organic matter is not proportional to the weight of the oxygen necessary to burn it, another resulting from the fact that hypermanganate of potash in acid or alkaline solution consumes the various organic matters very unequally. It is as if to find the weight of a body whatsoever, one would weigh an unknown variable fraction of it in a scale, one of the dishes of which would be moving blindly on the arm of the corresponding lever. There is, therefore, nothing precise to conclude from analysis of water by hypermanganate, whatever be the method adopted. It is to put in the hands of investigators not only a false but capricious scale, with the only argument that the weighing is easy.

All that can be said in favor of this method is that, when it is applied to the same water before and after filtration, it may give a good idea of the loss of organic matter during filtration. We may add, but always with a great deal of reserve, that the organic matter the most affected by the hypermanganate and acid solution being, after Messrs. Tiemann and Preusse, the most complex matters, the most nutritive for microbes, the most remote from the state to which microbic life brings them; it will be in preference to these matters that one must attribute the differences in analysis by hypermanganate before and after filtration.

We know how this analysis is made, by the aid of the dissolution containing 0gr,32 of hypermanganate of potash per litre and treated by means of a solution of oxalic acid. For instance 300cc. of water with an addition of 5cc. of sulphuric acid, diluted with twice the volume of water, with 10 or 20cc. of the solution of hypermanganate. After five minutes of boiling, a fixed period adopted, the liquid is not yet decolorized.

We complete the decolorization in adding a known quantity of the oxalic acid solution, and we treat the oxalic acid remaining in adding again hypermanganate until the reappearance of a persistent red color. A simple calculation shows the amount of hypermanganate destroyed by the organic matter of the volume of water used.

We designate generally in treatise on this matter, under the name of oxidability, the number of cubic centimetres of experiment liquor decolorized by 1 litre of water, after these five minutes of ebullition. In taking ten minutes, the quantity would be slightly increased. We may, instead of taking into account the number of cubic centimetres of the liquor of hypermanganate, calculate the weight of hypermanganate that was in it, or again calculate the oxygen that it may have yielded. With the method adopted 1cc.=0gr,.0008 of oxygen. Each savant has on this his habits in which it is useless to disturb him, for his results being always comparative, it matters not to what unit his figures relate. It is only necessary that he tells it so that, if need be, one may make the translations.

From what we have said above, this comparison does not inform us in the comparison of the materials of the water, the presence of which we would have the greatest interest to reveal. It cannot be either a matter of indifference to us to know if water has received oozings from cess pools, and the urea, which might warn us of the danger, the benzoic acid of the urine of herbivorous animals, and the amide products, as leucine, tyrosine, glycocol, produced by the transformation of nitrogenized matter are little sensitive to the action of hypermanganate of potash in acid solution, perhaps for the same reason which renders them very resistent in face of the oxidizing combustion of the organism.—*Dx. Annales de L'Institut Pasteur.*

[*To be continued.*]

MEDICAL BACTERIOLOGY.

METHYL VIOLET.

(Or the fancy copyrighted name Pyoktanin.)

BY FLAVEL TIFFANY, M. D.,
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A few months ago Dr. J. Stilling, of Strasbourg, gave to the world in the April number of *Revue Generale D'Opthalmologie* his experience in the use of methyl violet in the treatment of various affections, more especially those of the eye.

When the article first appeared, May, 1890, I took the liberty of translating it, and, subsequently, my translation was published in two different numbers (not consecutive) of Dr. Lamphear's *Kansas City Medical Journal.* I commenced the use of methyl violet from the day I first read Prof. Stilling's article, for, at that time, I had on hand a case of suppurative iritis which had resisted all treatment, continuing step by step through the several stages of inflammation, until panophthalmitis seemed inevitable. The patient was an old man of seventy-two years ; of rather feeble physique, upon whom I had made extraction of a nuclear cataract some eight weeks previous to the attack of iritis. He had made a good recovery from the operation and with fair results, viz.: With + 11 Dv. 20-40. Could read number 2 with + 14 D. There was a slight amount of cortical substance remaining. The iritis did not ensue for a month after he had gone from the hospital, when it appeared quite suddenly one day, as he was sitting in the harvest field watching the harvesters at work ; he says as he crossed the lot from one shade tree to another in the full blaze of the bright harvest sun, he felt a sharp pain dart through the eye, and from that time he was not wholly free from pain, which gradually increased with intolerance of light and diminution of vision. It was several days after the attack before the patient returned to the city. When he presented himself I found an intense inflammation of the iris with plastic exudation into the front chambers.

Mydriatics and hot water applications were scrupulously used in connection with other anti-phlogistics, but all to no purpose, the inflammation mounted higher and higher and the exudation was more profuse and of a suppurative character, the iris becoming a deeper red until finally the whole chamber became blood-red ; the cornea began to grow steamy ; there was intense ciliary injection ; in fact the whole ball was aglow, and the lids swollen.

There was much pain and total blindness, and I despaired of any chance of saving the ball, much less any sight.

It was at this stage, that I read Dr. Stilling's article on methyl violet. I immediately had a preparation made, 1 to 1000, which I had dropped into the eye, one or two drops at a time, thrice a day. This caused no irritation, but for few hours there was little, if any, amelioration of the inflammation, although the eye felt better. At the end of the second day, there was perceptible abatement of the congestion, and the pain was nearly gone.

The amount of the medicine was increased. The conjunctival sac was filled at each application, morning, noon and night, and the inflammation gradually subsided.

The methyl violet was continued for about three weeks when the eyeball had become clear and free from inflammation. The shape and size of the ball had been perfectly conserved, the iris had assumed its natural color and brilliancy, although the pupil was nearly occluded, and there was only perception of sight. The patient returned to his home, in Kansas, with the hope, through the means of a subsequent operation, to be made in a few months, of regaining useful vision.*

It has been about six or seven months since I commenced the use of methyl violet in affections of the eye.

I have used it a great many times, and in many patients, and have kept a careful record of several of the cases. It has been mostly used in phlyctenular conjunctivitis and granular conjunctivitis.

In cases of trachoma, when treatment cannot be continued by me on account of patients being obliged to return to their homes out of the city, it has become my custom to prescribe a bottle of methyl violet (1 to 1000) to use at home three times a day, and it has been invariably the case, that these patients go on to recovery without any relapses, and that the medicine never acts as an irritant, but is always soothing and agreeable. I have used it with excellent effect in dacryocystitis by means of the lachrymal syringe. I have also used it in otitis media purulenta, but not with as marked benefit as in affections of the eye and lachrymal apparatus, and nasal catarrh.

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*Since heard that he could see to count fingers.

I have employed this agent in microscopy as a staining material, knowing its special and thorough action as a stain for different forms of microbes, and especially for the micrococci, and that it always means death to the bacillus when it comes in contact with it, striking, as it were, to the heart or nucleus of all cells, paralyzing all vital action at once ; but it had not occurred to me to employ it as a therapeutic agent even in those diseases which are generally conceded to have their etiology in the microbes, until my attention was called to it by Prof. Stilling's able article, to which I have referred.

Since I have been using this agent I have had the opportunity of employing it in a single case of gonorrheal ophthalmia.

As yet, of course, the remedy has not been sufficiently used to establish it as so valuable a remedy as Dr. Stilling would claim for it.

Methyl violet may be used both as a local topical, and general system agent, in fluid, or pomade, or spray one-twentieth to one per cent. It remains to be seen if it shall prove a valuable remedy in pulmonary affections, in pyemia, etc.

If it has a special predilection for the bacilli and cocci, we shall look for it as a boon in most diseases.

Within the last few days I have had occasion to use the methyl violet in two cases : One of irido-cyclitis and the other choroido-cycloiritis, both of a most serious nature. That of irido-cyclitis occurred in a reverend gentleman, Mr. D., aged fifty-five ; blue eyes. This patient consulted me December 9, complaining of quite a severe pain in the right eye with dimness of vision. Examination revealed acute inflammation of the iris with a more intense deep-red congestion of the sub-conjunctival vessels over the entire anterior scleral surface. The pupil was contracted and inactive, and would not respond in the least to mydriatics. A one-per-cent. solution of sulphate of atropia, dropped into the eye five or six times a day, made no impression whatever, not even controlling in the least the photophobia or congestion ; in fact all the symptoms grew steadily worse, and on the third day the cornea lost its transparency, became steamy, so that the iris was nearly hidden and the vision was gone. Could not see to count fingers ; the fellow's eye had taken on symptoms of irritation, and its vision was considerably reduced. At this period December 11, I ordered methyl violet one-seventieth per cent. dropped into the eye every hour in connection with the sulphate of atropia, and to my great delight the next day, December 12, I found the pupil dilated to more than twice its size of the day before, the congestion subsiding, the cornea clearer, and the vision sufficient to count fingers. The treatment was continued, and on the following day the patient was able to recognize a person across the room, pain was gone, redness less and pupil widely dilated ; December 15, pupil wide open and vision 20–80, eye fast recovering. The methyl violet has quite a mydriatic effect, and also controls the power of accommodation to a considerable extent, though it is claimed by some that it does not affect the power of accommodation. This fact I have verified many times by using it alone without atropia. In the above case I feel confident that the methyl violet, from its diffusability and germicidic effect on the pyogenic microbe, cut short the disease and so saved the eye. I do not believe that in this case the mydriatic effect of the atropia could have obtained without the methyl violet, besides the methyl violet controlled the irritating effect of the atropia to the cornea and checked the keratitis.

The other case, choroido-cycloiritis, occurred in a young man of twenty-five years ; dark brown eyes ; A. B. Patterson, from Nebraska, a station agent on the Missouri Pacific Railroad.

The history as gained from the patient was as follows : "While I was walking down the street, October 13, with a penknife open in my hand, I met a friend who, in play, knocked my hand with the knife so that the open blade pierced my right cheek, going into the eye, and then the doctor put a stitch in the eyeball, and assured me that the sight would be all right (a German doctor). For about ten days the sight was very good, and there was but little pain, and then the eye began to pain and I could not bear the light and the sight gradually diminished and the pain grew worse."

An examination revealed a scar of the right cheek, lower lid and eyeball. That of the eyeball about 10 mm. long, about one-third of which extended into the cornea from the inner inferior region, near the attachment of the inferior rectus muscle.

The cut of the cornea embraced the entire layers of the cornea, and evidently the blade went through the sclera and choroidal, though there was no evidence of its cutting the iris. The pupil was contracted and the vision was not sufficient to count fingers; photophobia intense. I ordered one-per-cent. solution of atropia to be dropped into the eye every two hours, night and day. The second day the patient was sent to my rooms, the mydriatic had not had the least effect. The ophthalmoscope revealed a grayish light-colored body, with small pale blood vessels mounting up over it, protecting from the region of the ciliary body, and the sclera immediately exterior was swollen or bulged. There was evidently detached retina, with exudation beneath it. At this date I commenced the use of methyl violet, and had it dropped into the eye every hour night and day. On the following day there was some dilation of the pupil and less pain and soreness. December 16, I injected a one-tenth-per-cent. solution 10 m. in the eye through the sclera. The soreness subsided; the pupil became more open although the exudation was much the same. Dr. Stilling speaks of injecting the vitreous of a rabbit without harm to the eye.

My experience so far has been that the good effect from this agent is especially to be realized in inflammation of the deeper structures of the eyeball, owing, probably, to the great diffusability and penetrability of the aniline traversing almost immediately the cornea, and sclera to the chambers of the eyeball, and having for its predilection the bacillus and micrococci. In ulceration of the cornea, I have used it with most excellent results in the form of pomade 1 to 200.

For marginal blephoritis the methyl violet pomade, one-half per cent., carefully worked into the roots of the lashes, by means of a spatula, works a speedy cure.

Prof. Stilling, from his bacteriological experiment, found that milk mixed with methyl violet would not sour, nor would butter become rancid ; that urine even could remain in a thermostat at 32° C. for a week without putrefaction or presenting any bacteria whatever ; in fact, any substance containing a solution of methyl violet, of even 1 to 32,000, is absolutely indemnified.

This agent acts as an antiseptic, killing the pyogenic bacteria, and, from its diffusability and non-destructiveness to tissues, it is superior to other known antiseptics, and especially to thermocautery which is so efficient a germicide, but can only be used at limited points. (Read before the Missouri Valley Medical Association, Kansas City, December, 1890.)

CONTRIBUTION TO THE STUDY OF ETIOLOGY AND PATHOLOGICAL ANATOMY OF THE ABSCESSES OF THE LIVER.

RESEARCHES BY PROF. AL. DEL RIO.*

Dr. Alejandro del Rio, assistant professor of pathological anatomy, at the University of Santiago, published in the *Revista Medica* of Chili an important work on the abscesses of the liver (suppurative hepatitis), a malady of the warm countries, which represents from 5 to 100 of the mortality in the hospitals of men at Santiago.

"If the actual tendence of the medicine," says Mr. Del Rio, "is to employ the etiology for the classification of diseases, we should not forget that this knowledge has not reached everywhere the extent and solidity necessary to overturn the pathological anatomy from the place which it occupied."

"We cannot deny that the knowledge of these causes has produced in medicine a deep and beneficial revolution, and that the benefit is so clear and evident that it cannot be denied by skeptics. But to take bacteriology for a unique guide, in which the light is subject to many illusions, is still premature."

**Revista Medica* of Chili, November, 1889, in 8 with 5 plates, work crowned by the Medical Congress of Chili in 1889 (text in Spanish).

"More practical and more positive results are obtained by the aid of these two sciences. Such is the rule that we follow in this study."

This is in fact the plan that Mr. Del Rio follows in the work which has for an object to seek the causes of tropical hepatitis, to study its nature rather than make a clinical and therapeutical study.

The author thinks that this malady is due to some external causes, and that its development is secondary, consecutive to other processes which have accomplished their evolution; that it is an infectious disease producing some anatomical lesions similar to those of other maladies of same nature, not due to common causes as cold, heat, traumatism, but to some special, external, organized agents.

He commences then by giving an extremely complete and careful description of the anatomical lesions, then a histological study of the affected tissues and of the morbid products, finally the summing up of the bacteriological researches executed with the aid of the best methods and of the most perfect instruments. Mr. Del Rio has used in fact, some apochromatic objectives of Zeiss, accompanied by their compensating oculars.

He found thus, both in the pus of the hepatitic abscesses and in the disorganized tissues from their walls, various micro-organisms, micrococci united, two by two, and forming groups, more or less large; in another case, larger micrococci; in a third, some bacilli of small dimensions confined to the middle, and the poles of which were less colored than the middle portion (gentian violet); in a fourth, bacilli taking less color at the poles, and presenting at the center a clear spot.

These details are represented in the colored figures, extremely pretty and of an excessively fine design.

Mr. Del Rio is led to think that these micro-organisms penetrate through the intestine which, 87 times in 100, presents dysenteric ulcerations; taken by the ramifications of the vena porta, they reach the liver of which they determine the decomposition. In fact, abscesses of the liver present clearly a necrobiotic character rather than phlegmasic.

"We find in our books of medicine that the intestinal ulcerations are often a *complication* of the hepatitis of the warm countries. We see the abuse which is made daily of the word "complication." The intestinal ulcerations are not complications of the hepatitis; they do not *accompany* it; they are very probably the place of entrance of the disease. On the other hand, should the lesions not exist, the epithelium of the intestine does not oppose an impassable barrier to the parasitic micro-organisms, especially in a country like Chili, where intestinal chronic catarrh is very frequent, as well as other lighter affections of the intestines which is accompanied with an active epithelial desquamation."

"But it is the dysentery which appears to furnish more often the place of entrance. The two maladies coincide in the proportion of 87.37 to 100."

From a study of the geographical distribution of the suppurative hepatitis in Europe, Asia, Oceanica, Africa and the two Americas, we find that this malady is more frequent in the countries where the intestinal affections are more common.

"In Chili, in particular, where the abscess of the liver is frequent, 11 per cent. of the general mortality in hospitals is due to dysentery."

"The predisposing or general causes are the climate, the variable temperature, with the latitude and altitude of the different regions of the Chilian belt, the humidity of the air, a bad or exaggerated alimentation and alcoholic drinks. The alcoholism has taken, in Chili, on account of its frequency, an exceptional gravity."

"At the rate we go, said Mr. Del Rio, our race, proverbially strong and robust, skilful in all kinds of work, especially those requiring strength and resistance to the rigors of the climate, is marching with a rapid step towards the most complete ruin. In fact, it is sad to confess it, it is rare to find in our people an individual who is not alcoholic in the full sense of the word. All, and particularly those of the class of workers, the peon, on account of the particular alcohol (it is the alcohol of the worst kind of grain) which they absorb daily, pass several days of the week in complete intoxication, oftener exposed to all the inclemency of the weather."

"Do not think," added he, "that I exaggerate. When we demand of the individual affected with hepatic abscesses as to what cause they attribute their malady, two-thirds attribute it to great carousals or to remaining without shelter, exposed to the weather, while they were intoxicated."

A remarkable fact, and which proves well the *role* that intestinal affections play in the production of the abscess of the liver, is a parallel march of dysentery and of hepatitis. Mr. Del Rio represents by the aid of graphics the results furnished by the statistics taken since 1870, and we find the maxima or minima in the localities and in the years where occurred the maxima and minima of dysentery.

Moreover, as the hygienic conditions in which the populations live improve, and they improve year by year, thanks to the efforts of the administration, the diseases of the intestine diminish, and at the same time the abscesses of the liver.

So that, were it not for alcoholism, this cause of disease which does not diminish, dysentery as well as hepatitis are two affections which, declining in frequency every year, would disappear some day.

We cannot insist further on the work of Prof. A. del Rio. This is not only the best that we know on this subject, but we give it as a model both from the standpoint of method and concerning the anatomical and bacteriological researches.

This work of Mr. Del Rio obtained last year the prize given by the Medical Congress of Chili.—*Journal de Micrographie.*

HYGIENIC BACTERIOLOGY.

REVIEW OF M. ZAGARI'S RESEARCHES ON THE MECHANISM OF THE ATTENUATION OF RABIC VIRUS.

In a work which has been analyzed in these *Annales,* Mr. Protopopoff has drawn the conclusion that it is chiefly the heat, and not the desiccation, which intervenes to attenuate the virus of rabic marrow, which is used in vaccination by the Pasteur method. I had made the observation on this subject that we remained in the vague so long as we are contented to say it is the heat which acts, and that it would be useful to search how it acts, and if it is not in putting in play a phenomenon of oxidation.

This call to new researches has been answered by Mr. Zagari, who has studied comparatively the influence of the sojourn of the marrow in the air, in the pneumatic space, in carbonic acid and in oxygen. In each of these series of experiments he has varied the conditions of preservation, in leaving, or not, potash in the presence of spinal marrow, suspended in a drying flask, or immerged in sterilized, distilled water, or a broth mixed in glycerine in equal parts.

Lastly, he has made some comparative experiments at 20° C. and 35° C., in order to see the influence of the heat. This last is not doubtful. Whatever be the mode of preservation, the virulence lasts longer at 20° than at 35°. For example, through the air, and in the presence of potash, that is to say, in the ordinary conditions of preservation of the marrow in the various anti-rabic institutes, the virulence is not extinguished at the end of 10 days passed at 20°, whilst it disappears at the end of 66 hours at 35°.

This being well established, it was natural to operate on this last temperature in order to study the mechanism of the action of the heat. This action is then more rapid, and the experiments shorter. Without my insisting, we guess the disposition of these experiments. I will say, only, that, in order to make the vacuum on the marrow, Mr. Zagari recommends highly the use of mercurial pumps, which we are astonished, in fact, to see so much neglected, and replaced by complicated arrangements which are not worth them.

The heat has, for sure effect, to accelerate the desiccation of the marrow. Let us see, in the first place, if the desiccation does not intervene by itself, contrary to the opinion of Mr. Protopopoff. It suffices to compare between them the marrows preserved in the presence of the potash or those immerged in water or the glycerinated broth. We find thus that the virulence remains nearly twice as long in the immerged marrow; thus the desiccation has a special action, independent of that of the heat. But the heat, which certainly produces a desiccation more rapid, is able, also, eventually, to hasten the phenomena of oxidation. In order to know what their proper action is, it suffices to compare the marrows, preserved in the same conditions in the air, in the vacuum, and in the presence of carbonic acid. Mr. Zagari has thus found, among other results:

First. That the marrows suspended in a drying flask, in the absence of potassium, lose their virulence after 56 hours in the air, but still retain it after 121 hours in the vacuum, and after 198 hours in carbonic acid.

Second. That the marrows suspended in the presence of potassium lose their virulence after 66 hours passed in the air, and retain it after 116 hours in the vacuum.

These results, to which we could add those drawn from the comparison of marrows preserved in broth or in water, suffice to show that the heat puts in action a phenomenon of oxidation.

Does this action reduce itself to this phenomenon of oxidation? One would think not, in noting that the marrow attenuates itself in the hands of Mr. Zagari, notwithstanding the minute precautions taken by this *savant* in order to free it from oxygen. But it would be concluding too hastily, and Mr. Zagari leaves, with wisdom, the question in suspense. The marrow is in contact with the air while we extract it from the medullary canal, the oxygen contracts with it some of those unstable combinations, analogous to that which it contracts with the hæmoglobin, that the pump of mercury does not destroy, and which can serve as ulterior oxidations. It is true that this source of oxygen is of the most mediocre, but it does not take much gas to oxidize a matter so imponderable as a virus. The question remains, then, pending. It has, on the other hand, moderate importance, and the main, essential point was to show, as Mr. Zagari did, the intervention of a phenomenon of oxidation in the attenuation of rabic virus.—*Dx. in Annales de L' Institut Pasteur.*

BACTERIA AND PLANT DISEASES.

BY T. J. BURRILL, PH. D.

Bacteria were long known as having a causal relation to disease in animals, before they were in plants. In De Bary's *Vorles ungen ueber Bacterien,* published in 1886, he tells us that : "Parasitic bacteria do not often occur, according to our present experience, as the contagia of plants." Now De Bary was, at this time, the best botanist in Europe making a leading specialty of fungi, and in particular of parasitic fungi, hence of the diseases of plants. He also gave prominent attention to bacteria, as his book just named gives ample evidence. As a matter of fact, the first paper, upon a disease of growing plants due to bacteria, was read in August, 1880, before the American Association for the Advancement of Science, by the present writer, upon the so-called blight of pear and apple trees. Since that time, there have been too many plant diseases attributed to these organisms to make De Bary's statement true for to-day. Several of these have been made known by European investigators, but, in this one particular, the Americans seem to have taken, and to have kept, the lead. More of such diseases have been worked out and described in our country than anywhere else,—not probably because we really have more of them, but because attention has been specially directed towards them. The known number is also rapidly increasing, due to the activity of several investigators, and to the recognized importance of the studies.

The literature upon the subject is, however, widely scattered. There exists no other publication in the world in which a department is provided for this special purpose. The existing periodicals of the Old World, devoted to bacteria and their allies, are concerned alone with the diseases of animals, except for occasional references to those of plants. On the other side, as with us, the botanical journals have been the main avenues by which authors upon our special topic have sought the public eye. In the want of a more specialized publication, this was the best that could be done, yet it has no doubt occurred to others that the diseases of animals and of plants, due to the same class of parasites, ought to find publication together. This is true whether or not the matter is also contributed to the more general journals, in the future as in the past. The results of investigations in one kind of host will very probably aid the investigator upon the other hosts. There is also much probability that in some cases the self-same organism holds a causal relation to certain diseases of both plants and animals—a thing not heretofore sufficiently appreciated. The question of the origin of "disease germs" is still an exceedingly important one, and possible contributions to knowledge here may come from studies upon the bacterial diseases of plants.

There is still another reason for which these parasitic diseases of plants should receive more attention on the part of bacteriologists. No *living* animal tissues can be sectioned in the microtome, and the thin slices studied under a high-power objective. But this can be done with plant tissues. There is far greater hope of being able to find out in the latter case just what action the invaders have in the regular course of their development, in what special manner they accomplish their destructive results, and just what favors or hinders their progress. If animal bodies could be thus taken apart and the small pieces still retain their vital activity, it is easy to suppose that many obscure problems would have been cleared up before this time, which now remain obscure. It will no doubt be an excellent thing for the animal pathologist or bacteriologist to acquaint himself thoroughly with the bacterial diseases of plants, and it certainly is desirable that he who would study such maladies of plants should keep abreast with what is accomplished in the studies upon the transmissible diseases of animals.

It is proposed that some account shall be given in this department of the BACTERIOLOGICAL WORLD of every disease known in plants, both at home and abroad, which is attributed to bacteria, and at the same time the endeavor will be made to gather every item of information of possible bearing upon the study of these diseases. To this end investigators and authors are solicited to contribute results of research in formal papers, and to freely communicate items of all kinds and of every degree of importance bearing upon the subject. By all means let us have the little observations and discoveries too likely to be considered insignificant. Nothing of the kind can be too little. What have you now of this nature ? Please send it along.*

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*Address contributions on this subject to Prof. T. J. Burrill, Champaign, Illinois.—ED.]

ORIGINAL ARTICLES.

THE PRINCIPLES OF ANTI-RABIC VACCINATION—Continued.

BY PAUL GIBIER, M. D.,
Director of the Pasteur Institute, New York.

(Continued from January Number.)

4th. *After inoculation the animal survives; immunity has been acquired.* Though it is somewhat inconstant, for it produces itself only in a certain number of cases, immunity may become acquired after a single subcutaneous injection more or less abundant of rabic virus. In this occurrence we enter in the order of phenomena on which the Pastorian method of preventive inoculation against rabies finds itself established.

Though rabies is considered as a mortal malady, I do not think I am premature in sustaining that in a good number of cases after a bite, notwithstanding the introduction of the contagious elements in the organism and even in the nervous tissue, death is not produced, and the disease may pass unnoticed. More than that, more or less serious symptoms of the invasion of the nervous system by the microbes of rabies may manifest themselves without a necessarily fatal issue. Bourrel (*) cites several observations of cure of rabies in animals; Leblanc, Jr., (†) has reported an observation of the same kind in the dog. A number of observations of rabies terminating in recovery have been also observed in man (‡).

It is not impossible then for the nervous system to free itself of the rabic parasites; we understand easily, after this, the facility with which the cells of the cerebro-spinal system may resist the virus by means of methodical vaccination. I have demonstrated by my experiments on birds (chicken, pigeon), that the microbe of rabies would not necessarily determine incurable poisoning of the nervous cells. I have proven (§) that this class of animals contracted rabies rarely, but could transmit it in a mortal form to mammalians, proving that the former recovered spontaneously. In case when they appear on the point of succumbing when the quantity of virus injected has been too great, it is still possible to preserve them from death in sustaining their strength by artificial alimentation. Let me draw your attention, by the way, to the fact that birds may give a good experimental demonstration of acquired immunity, for as I have seen by experiments when they have once been attacked by and cured of rabies, it is impossible to make them contract this malady a second time.

It was necessary, to produce the admission, and the understanding of the probability to render the organism refractory to rabic virus, to recall the facts that I have just explained. Let us now try and penetrate the principle of anti-rabic vaccination. Let us recall, in a few words, what this vaccination consists of: A man has been bitten by a rabid animal; several weeks, several months and even several years may lapse before the accidents of rabies manifest themselves. Being given that we can accustom the animals to the attack of rabic poison, Pasteur's idea was to try and profit of the more or

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(*) Treatise on rabies; Paris, 1874.

(†) Dictionary of medical sciences, article Rabies, page 128.

(‡) Lucas Benham—The Lancet; March, 1890. In fifty observations of human rabies terminated by cure, one-half, at least, appear to have been some very authentic cases of hydrophobia.

(§) Experimental researches of rabies, Paris, 1884.

less prolonged delay, which separates the bite from the apparition of the accidents, to create immunity in accustoming the nervous system gradually to the strongest virus, before the morbid germ introduced by the bite of a dog has had time to invade it. I will not tarry to discuss the efficacy of the antirabic injection. I think that for all enlightened non-prejudiced minds the proof is made. Let us pass, then, immediately to the examination of the conditions which render the cells capable of resisting the invading microbes in such a way as to repulse them victoriously. The remarks which follow may be applied to a great number of contagious diseases, against which we have been able, or may be able in the future, to create artificial immunity. The first injections of the series of antirabic inoculations, according to Pasteur's method, are composed of liquids which are *not virulent*, that is to say, they do not contain any *living* microbes. This substance alone would probably be insufficient, at the dose ordinarily employed, to create immunity, and still we cannot say that it is absolutely necessary to obtain liquids containing the living microbe to create the refractory state for, as far back as 1886, Pasteur announced that he had been able to produce this refractory state in dogs, and guinea-pigs, to which he had inoculated nervous matter from rabid animals, and in which it had been impossible to reveal the presence of living germs by injection in the arachnoid of rabits. Does this imply that the refractory state may be produced, and is produced, chiefly by the soluble substances secreted by the microbe? In the last years numerous examples have been furnished us of the refractory state by the aid of soluble substances secreted by germs; I have just cited the experience of Pasteur on rabies; I will recall, also, that Babes for the same disease (*) has obtained, in certain stages, the refractory state by the soluble substances alone. Immunity against bacteridian anthrax has been conferred to the susceptible animals (†). (‡) The soluble substances alone have given

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(*) Annals of the Pasteur Institute, July, 1889.

(†) Pasteur. Comte Rendus of the Academy of Sciences, January 30, 1888.

(‡) Roux and Chamberland. Annals of the Pasteur Institute, August, 1888.

the same results in the hands of Mr. Salmon against hog cholera ; we find the same against septicemia (*), against symtomatic anthrax (†) against typhoid fever (‡). We may admit, therefore, that in anti-rabic vaccination the soluble substances play an important role. I would not, however, admit the preponderance of their role. However, let no one misunderstand my thought, I will say even that without the presence of soluble substance, in the particular case that interests us, there would be no vaccination possible, but that this vaccination is secured by the presence of the living germs which secrete those soluble substances. I will explain myself. When an emulsion of rabic virus is injected in the subcutaneous cellular tissue, a certain quantity of liquid containing chemical substances secreted by the microbes is immediately absorbed. In this way the whole organism, and the nervous cells in particular, are more or less affected by the contact of these chemical principles. I have noticed that the persons who submit to inoculation are much more tired during the first four days of treatment and during the following days, though the points of inoculation are much less sensitive and much less irritated than at the end (§). During these first inoculations it is only those substances which are injected. The nervous cell, therefore, accustoms itself from the beginning to the products secreted by the microbes. When this living microbe is in its turn inoculated it is at first put in contact with a cellular tissue irritated by the preceding inoculations ; this cellular tissue is accustomed to the secretions of the rabic germ, and it is probable that, at the point of inoculations, it suffers a shock which weakens it, and, when it is carried by one way or another to the central nervous cells, not only it finds them prepared for battle because they are already in a degree accustomed to poisons which the microbe secretes and the latter is weakened, but also very likely because a certain proportion of the soluble substance elaborated by the microbe has remained in the organism and that the presence of

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(*) Roux and Chamberland. Annals of the Pasteur Institute, December, 1887.

(†) E. Roux. Annals of the Pasteur Institute, February, 1888.

(‡) Chantemesse and Widal. Annals of the Pasteur Institute.

(§) This is equally trua as I have observed in myself.

this substance is unfavorable to the development of the germ which has produced it. Let us add finally, that the cells of our organisms are in some sense microbes living collectively. Their secretions, like those of other microbes, are injurious to them when they are not eliminated ; but before they are eliminated they oppose, in a certain measure, invasion by external microbes. If it were not thus there would not be a single microbe in the world that would not be pathogenic. This may account for a limited refractory state, but it does not explain to us how this immunity may last several years. We must confess that the theory of retention, that Prof. Chauveau has especially defended, is scarcely tenable with the exception of in the few days which follow inoculation, or the first attack of the malady. There is another theory, according to which, the microbe of a special affection could not develop itself again in an organism where it had previously produced a disease, and this because of the destruction, forever, of certain principles indispensable to its development. This theory of immunity does not appear to me more acceptable, for what would remain in the organism which would have been affected by a large number of contagious maladies if each of these maladies destroyed a "principle" of it? The experiments of Mr. Metschnikoff show us well the manner in which *certain* cells of the organism battle against invading microbes, but I do not think that we must consider the white globules, phagocytes, the unique and indispensable agents of immunity. In the war of the cells they represent, so to speak, only the scouts ; the bulk of the army remains stationary, and guards its pontoons. I have already written it on several occasions : In the *production* of immunity several causes are instrumental ; among these causes some or others predominate according to the disease. In rabies immunity begins by the soluble substances which *train* the nervous cells to resist the toxic products, and then by the secreting germs of the toxic products which come, already attenuated, in contact with the cell ; but this does not explain how this immunity continues during a more or less extended period. To have a correct idea of the principle of immunity in general, we must leave the narrow limits of mechanism, and see in the nervous cells, as in all the other living cells, a microcosm of man, as man is a microcosm, a reduction of the universe. The cell is constituted by three fundamental principles : it is formed of organic *matter,* and it has its soul, that is to say its portion of vital *energy*, and it is endowed with a proportional *intelligence.* Among the psychical qualities of a cell we find memory, an automatic memory I will concede, but memory, nevertheless ; and it is by the aid of this faculty that it remembers the processes of resistance that it has employed against this or that germ, the vital vibrations of which were inharmonious with its own, and it is without trouble that it returns at once to the same processes without giving to the parasites time to develop themselves at its expense, and to acquire strength for another attack in the future. This state of immunity may, however, be arrested for a time ; the cells may find themselves in a moment of vital depression, they may be surprised anew, or the period of time elapsed may be too great, and *immunity* is *thus forgotten.*

In conclusion, I think that the mechanism of anti-rabic vaccination does not differ perceptibly from that which produces the other immunity : the habit (*accoutumance*), or, if it is preferred, the training of the cells is produced first by contact of the soluble substances secreted by the microbes before it is put in direct contact with these. In other cases of vaccination the soluble substance is put in contact with the cells when the microbe which secretes it is in their presence. As to the principle itself of immunity against rabies, it does not differ from that which directs its evolutions and assures its perennity in other maladies ; in my opinion it is a phenomenon of cellular memory.

HYGIENIC.

THE PRODUCTION OF IMMUNITY WITH THE CHEMICAL SUBSTANCES FORMED DURING THE GROWTH OF THE BACILLUS OF HOG CHOLERA.

BY E. A. V. SCHWEINITZ, PH. D.

Chemical Laboratory, Bureau of Animal Industry, Department of Agriculture, Washington, D. C.

As a continuation of the preliminary paper on the ptomaines from the hog-cholera germ, presented by us to the Chemical Section of the American Association for the Advancement of Science, in August, and published in *The Medical News*, September 6, 1890, we present now a somewhat detailed account of the successful experiments in the production of immunity in guinea-pigs which have been made up to date. The work from this standpoint again is of course a practical continuation of the experiments of Drs. Salmon and Smith, made upon pigeons in 1887, in which sterilized culture-media were used for preventive inoculation. * * * *

As to the name which should be given to the ptomaines and albumins from the hog-cholera culture-liquids, until their chemical constitution is more thoroughly studied, it would seem best, as there are several distinct swine diseases, to call the ptomaines from the hog-cholera germs, as a class, *sucholotoxins*, and the ptomaines which appears to be the principal factor *sucholotoxin* (from the Greek Σῦς, a hog, *Χολέρα*, cholera, from *Χολὴ*, bile, and *toxikon*, poison). Sucholo-albumin would seem to be sufficiently distinctive for the albumin of these culture-liquids. As Hankin* shows, the name *toxalbumin* is hardly the correct one to apply to these substances. We shall, therefore, refer to the ptomaines and albumin by the names given above.

The first of our experiments that we will record were made with sucholotoxin.

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*British Medical Journal, 1889, p. 810.

Experiments 1.—Two guinea-pigs, each weighing about three-fourths of a pound, were treated with a solution of about 0.05 gram of sucholotoxin each. The solution was introduced under the skin of the inner side of the left thigh. Immediately after the operation the animal appeared uncomfortable, but was not made ill. For a few days there was a rise in temperature and also a slight swelling at the point of inoculation, which, however, disappeared in about five days, and the animal was then well.

Two more guinea-pigs were now selected as checks, approximately of the same size and weight as those which had been treated, and the four animals were then inoculated with 0.1 cc. of hog-cholera virus each (0.1 cc. beef-infusion and peptone culture one day old, plus 0.2 of sterile, normal salt solution.) This is the dose which previous experiments made in the Bureau had shown to be the proper quantity to kill a guinea-pig in from eight to ten days. The inoculations with the virus were also made subcutaneously in the thigh. The checks died in eight and nine days. *Post-mortem* examination showed a large swelling at the point of inoculation, infiltration of a purulent, grayish substance into the connective tissue, and necrosis of the superficial layer of the muscles of the thigh. Enlargement and reddening of inguinal glands. Peyer's patches enlarged and pigmented; liver pale and covered with a number of necrotic foci; spleen very much enlarged, dark-colored and friable. Cover-glass preparations from the spleen and liver showed hog-cholera germs. This was the characteristic appearance of all the check guinea-pigs upon *post-mortem* examination, and it will not be necessary to repeat these details.

Of the animals which had been first treated with the substance mentioned, and afterward inoculated, one died two days after the last check. Autopsy revealed the following: At the point of inoculation in the left thigh the subcutaneous tissue was infiltrated with a grayish-white substance, and the superficial layer of muscles over the inner side of thigh, and 4 square centimetres of the abdominal wall were necrosed. Liver pale. Spleen much enlarged, dark colored and friable.

Cover-glass preparations from the spleen showed a large number of hog-cholera germs. Both ventricular walls of the heart were light grayish and very brittle (necrosed). The other guinea-pig of this set was quite ill for ten days, with a large swelling at the point of inoculation. This finally opened and healed, and the animal was quite well within three weeks after the inoculation, and has continued so to date—five months.

EXPERIMENTS 2.—The next series of experiments were made with sucholo-albumin from beef-infusion and peptone culture-media.

Two guinea-pigs were again selected and treated with about 0.008 gram each of sucholo-albumin. There was a slight rise of temperature in the animals and the formation of a small, hard lump at the point of injection. This disappeared by the eighth day and the animals were quite well. Two more guinea-pigs were now taken as checks, and all four animals were inoculated with 0.10 cc. of hog-cholera culture. The checks died within seven days. The *post-mortem* appearances were practically the same as those noted in the first series. The two guinea-pigs which had been treated with the sucholo-albumin died *ten* days after the checks. This indicates considerable resistance to the disease. Autopsy showed, at the point of injection with the albumin, the subcutaneous tissue thick and reddened. The animals were considerably emaciated. At the point of inoculation a cyst the size of a walnut, and composed of a grayish, purulent substance, was also found. The muscular wall surrounding this was sprinkled with punctiform hæmorrhages. Peyer's patches swollen and pigmented; mucous membrane of small intestine covered with a dry, yellowish, firm layer of mucus; stomach contained a considerable quantity of liquid; liver pale, and showed fatty degeneration; spleen slightly enlarged and dark. Cover-glass preparations showed no germs, but a culture made from the spleen showed hog-cholera germs. Beneath the peritoneum in the region of the spinal column, and in the mesentery was a considerable number of small grayish tubercles. Several other experiments were made by treating guinea-pigs with the albumin in varying quantities, all showing resistance, and subsequently immunity.

Experiments 3.—Three guinea-pigs were treated with sucholo-albumin, 0.1 gram being given to each, subcutaneously in the thigh. The albumin for two of the animals was derived from cultures containing blood-serum, the albumose given to the third was from ordinary beef-infusion peptone culture. Ugly ulcers formed at the point of inoculation, which healed, however, in from ten to fourteen days, and the animals with the exception of a slight rise of temperature were well.

Two checks were again selected, and the five animals were inoculated with 0.1 cc. hog-cholera virus. The checks died respectively in eight and ten days from hog cholera. The animals which had received the preventive treatment were slightly ill for a few days with swelling at the point of inoculation, which finally opened and then healed nicely, and within a week the guinea-pigs were well.

Three weeks after the inoculation, one of these animals was chloroformed and examined *post mortem.* Not the slightest scar could be discovered; all the organs appeared perfectly normal, and no germs were found.

Experiments 4.—Four guinea-pigs were treated, two with a mixture of sucholotoxins, two with sucholotoxin and albumin. The injections were made as before, subcutaneously in the thighs, and at intervals extending over a period of four weeks. The sore caused by each injection was allowed to heal before the next one was made. After the animals had recovered from the last treatment two checks were selected, and the six were each inoculated with 1-10 cc. hog-cholera virus. The checks died, one in eight and the other in ten days, the *post-mortem* examination showing characteristic hog cholera lesions. The animals having the preventive treatment were ill for about four days; those that received only the sucholotoxins being more dull than the others. There was also slight swelling at the point of inoculation with the germ, which subsided in ten days, after which the animals were perfectly well, and have remained so—four months.

(*To be continued.*)

SCIENTIFIC GLEANINGS.

A NEW POISON IN CHEESE.

BY VICTOR C. VAUGHN, M. D.

During the past two or three years, we have received at the Hygienic Laboratory of Michigan University a number of samples of cheese, which, it was claimed, had caused nausea and vomiting in those eating of them, and in which we were unable to detect tyrotoxicon. Some of these samples produced vomiting and purging in cats and dogs to which the cheese was fed directly. Of course, the evidence that these samples had been the actual cause of the sickness among the people who had eaten of them was confirmed by the experiment upon the animals; but, inasmuch as we were unable to detect the poison, we were compelled to report as follows:

"The poisonous character of the cheese has been proven by experiments upon animals, but we have failed to demonstrate the nature of the poison. Tyrotoxicon could not be detected."

One sample of this class was found by my assistant, Dr. Novy, to be very poisonous. Some of this cheese was covered with absolute alcohol, and, after standing in a dish for some weeks, the alcohol was allowed to evaporate, then 100 grams of the cheese were fed to a young dog, and caused its death within a few hours. Sterilized milk, to which a small bit of the cheese was added, after standing in the incubator at 35° C. for twenty-four hours, became so poisonous that 100 cc. introduced into the stomach of a full-grown cat caused death. Dr. Novy made plate cultures from the cheese and from the spleen and liver of the dead animals, and succeeded in identifying one germ as common to both. Sterilized milk inoculated with a pure culture of this germ, and kept in the incubator, proved fatal to cats. But with the advent of cold weather the germ lost its toxicogenic properties, which were not restored by subsequent cultivation in the incubator.

In a second class of samples, the poisonous character of the cheese was not confirmed by direct feeding. Cats, rats and dogs were fed with the same quantities as above, without any appreciable effect. The report made upon the samples was as follows :

"Animals fed upon the cheese were not affected. Tyrotoxicon could not be found. The sickness of the people was probably due to some other cause."

The last sentence of this report was probably wrong, as will be shown from the following experiment : Two kilograms of a cheese of this class were extracted repeatedly with absolute alcohol. The part insoluble in alcohol was then extracted with water. The aqueous extract, after filtration, was allowed to fall slowly into three times its volume of absolute alcohol. A voluminous, flocculent precipitate resulted. After twenty-four hours, the supernatant fluid was decanted, and the precipitate was dissolved in water and reprecipitated with absolute alcohol; then it was collected and speedily dried on porous plates. A small bit of this precipitate was dissolved in water, and forty drops of this solution, injected under the skin on the back of cats, produced, invariably within one hour, vomiting and purging. After the partial collapse which followed the vomiting and purging, and which was evidenced by the animal sitting with its chin resting on the floor, recovery gradually followed. The same amount of the solution injected into the abdominal cavity of white rats rendered the animals, within ten or fifteen minutes, perfectly limp, and the only evidence of life observed was rapid respiratory movements. The rats lay upon their sides, and could be handled without manifesting any attempt at movement. In this condition, some died after three or four hours, while others, after lying in this position for from eighteen to twenty-four hours, gradually improved, and, after some days, seemed to be wholly recovered.

This substance belongs to the so-called poisonous albumens. From its aqueous solutions it is not precipitated by heat or nitric acid, singly or combined. Its solutions respond to the Biuret test. It is not precipitated by saturation with sodium sulphate, nor by a current of carbonic acid gas ; therefore, it is not a globulin. It is precipitated by saturation with ammonium sulphate ; and this fact removes it from the peptones.

That animals were not affected when fed with the whole cheese may be explained by the supposition that they did not in this manner get enough of the poison to affect them. It cannot be said positively that the samples of cheese of the first class mentioned above owe their poisonous properties to this substance. We have not had the opportunity of testing samples of this class since the recognition of the poisonous albumen in those of the second class. Four samples of the latter have been tested for the poisonous albumen, with positive results.

It may be found that traces of this poison exist in all samples of green cheese. This point will be investigated.

It is highly probable that the poisonous effects of some samples of sausage and meat are due to similar products of bacterial activity.—*Medical and Surgical Reporter.*

ACTION OF LIVING BLOOD ON BACTERIA.—Prof. Bonome has recorded the results of his researches on the following points: Whether physiological alterations in the blood play any part in modifying its destructive action on bacteria; whether it is possible to produce the alterations in the composition of the blood of such a nature that the normal, inimical action against bacteria may be altered; and whether it is possible to derive any reliable data that will throw light on the subject of immunity. As a result of his experiments he comes to the conclusion that staphylococci introduced directly into the blood are destroyed in from ten to twenty-five minutes; more rapidly in the blood of young rabbits than in older animals of the same species. He then, by injecting the poison obtained from the pus of an old empyema or a chronic abscess in small quantities into healthy rabbits, proved that the bacteria-destroying activity of the blood is increased, the organisms used being staphylococcus aureus, albus and citreus. He holds, however, that the introduction of such poison does not appear to exert any influence upon the similar activity of the fixed tissues. Poison from acute pus obtained in a similar manner appears to exert not the slightest influence on the destructive action of the blood; while, owing to its effect upon the tissue elements, it diminishes their power of destroying such organisms as the staphylococci above mentioned. Similar poison from pyogenic staphylococcus cultures does not increase this destructive power of the blood against the above-mentioned organisms, and any immunity that is produced depends not on the rapidity and certainty with which the blood destroys the organisms introduced into its stream, but rather upon a greater resistance which the tissue elements exert against the bacteria poison, when they have become accustomed to the action of the poison by remaining in contact with the metabolic products of the same bacteria. He also gives experiments to show that water injected into the veins can diminish this destructive activity of the blood to a certain extent, but never completely; for, although the animals so injected and control animals died about the same time, those in which water had been injected usually showed small purulent deposits in the kidneys and myocardium, and more or less fatty degeneration of the epithelium of the kidneys, so that he considers that, in addition to this slight diminution in the destructive activity of the blood, there is some alteration of the protoplasm of the cells, probably due to the absence of salts and the cutting off of the full oxygen supply by the presence of water, by which their resistance is considerably diminished in certain areas, and owing to which they are more readily attacked by the injected staphylococci.—*British Medical Journal—Journal of Medical Association.*

TECHNIQUE.

STAINING TUBERCLE BACILLI.—Dr. M. Friedlander (*Therap. Monat.*) has devised a simple method of examining sputa for tubercle bacilli, by which two preparations can be completed in from five to ten minutes. The solutions necessary for this purpose, and which should be kept in readiness for use, are : *First.* Ziehl's solution, viz., a 5-per-cent. watery solution of carbolic acid, to which an alcoholic solution of fuchsin has been added to the point of concentration. *Second.* A solution of 5 grams of pure nitric acid in 100 grams of 80-per-cent. alcohol. *Third.* A concentrated watery solution of methylene blue. The coloring process is as follows: The smallest possible quantity (about the size of a pin's head) of the specimen to be examined is taken up with a pincette or needle, and spread, by means of another clean needle, over the surface of a slide, in a thin layer about as large as a five-cent piece ; it is then dried in the air, during which time a second preparation is begun. The first one, when dry, is twice drawn slowly through the flame of a Bunsen burner or spirit lamp. It is next covered with 2 or 3 drops of the fuchsin solution, and held over the flame, with the smeared side upward, until it begins to steam. It is then washed with water and covered with a few drops of the nitric-acid solution, which are allowed to act about half a minute, or until the color has quite disappeared ; then the acid solution is also washed off with water. A few drops of the methylene-blue solution are now added and allowed to act, without being heated, until the second preparation is equally advanced. The first preparation is again washed with water, then thoroughly dried with blotting paper and over the flame. It is now stained, and may be covered directly, without using a glass, with a drop of cedar oil, and microscopically examined. Two of these preparations will generally suffice for the investigation of a sputum.—*Exchange.*

STAINING BACILLUS TUBERCULOSIS IN MILK.—While milk is, doubtless, one of the most common sources of infection in typhoid and in tuberculosis, from its very composition, unfortunately it is very difficult to demonstrate the presence of these micro-organisms in any given sample of the fluid. May's process of precipitation of the casein is very unsatisfactory, and in lieu thereof a writer in the *Monitore dei Farmacisti* suggests saponification of the fat globules by the following process : A drop of the milk is placed on a glass slip and two or three times its volume of a 1-per-cent. solution of sodium carbonate is added, and the fluids mixed, with the aid of a platinum wire. The slip is then cautiously held over the flame of an alcohol lamp, or over the chimney of a kerosene lamp, and the liquid slowly evaporated to dryness. During the evaporation the butter particles are saponified, leaving a thin layer of desiccated soap on the slip. The subsequent treatment is identical with the older processes (staining with fuchsin, etc.). Rapid coloration with intense solutions of the reagents is preferable to the slower methods.*

KUHNE'S METHOD OF STAINING TUBERCLE BACILLI.—In a recent number of the *Centralblatt fur Bakteriologie and Parasitenkunde* Kuhne gives a new method of staining tubercle bacilli devised by him to avoid the fallacies and difficulties which beset the examination of phthisical sputum. The main difficulty, according to him, is that of getting the sputum properly spread on the cover glass, and, to avoid this, he shakes up the material with an equal quantity of a concentrated solution of sodium biborate. The effect of this is to render the material liquid and easily spread. The nummular matter from cavities he treats in a like manner, with a solution of ammonium carbonate, the latter being partially decomposed on heating the cover glass, a portion being volatilized. The subsequent steps are the same as in the old methods, heating of the cover glass over the lamp, staining with fuchsin, and bleaching with nitric acid and alcohol. The counter or ground stain suggested by Dr. Kuhne in place of methyl blue is a solution of picric acid in aniline oil. We have tried this method, and, while the results are not so good as those obtained by following Biedert's technique, Kuhne's modification is so much simpler that it is to be preferred in all cases except those in which it is desired to make a "show" or typical slide.*

KULTSCHITZKY'S FLUID FOR HARDENING AND PRESERVING MATERIAL FOR MICROSCOPICAL EXAMINATION.—The following is the method of Dr. N. Kultschitzky for the preservation of organic matter and its preparation for sectioning and staining:

The fluid.—Supersaturate alcohol of 50° with a mixture of equal parts of pulverized potassium bichromate and cupric sulphate, and leave in absolute darkness for twenty-four hours. Decant, and keep in a dark place. Before using, add about 1-4 of 1 per cent. (2.5 parts to 1,000) of glacial acetic acid.

To use.—Put the object into this fluid and leave for from twelve to twenty-four hours, according to the size and density of the material. This must also be done in the dark. Transfer to alcohol of 95°, and in the course of twelve to twenty-four hours it will be ready for sectioning.

In an article on the subject published in the *Zeitschrift fur Wissenschaftliche Mikroskopie* some time ago, Kultschitzky gives the following general rules: For fixing the tissues it is important to use reagents that do not form tissue-like precipitates with protoplasm. This requirement is met by chromic salt, sulphate of copper, sublimate, and some other salts. Preparations in chromic salts, when transferred to alcohol, should be kept in absolute darkness (H. Virchow), until the fixing reagent is removed so far as possible.

All reagents which transform protoplasm into tissue-like forms, as, *e. g.*, chromic acid, should be avoided, or their application must be controlled.

Fixing fluids should contain an organic acid, *e. g.*, acetic acid, which changes nuclein into an insoluble state. The acid must be used in a diluted form, as nuclein is dissolved in strong acid. The time of action must be short, as the long continued action of even a weak acid dissolves nuclein.

It is desirable that the fixing fluid should contain alcohol in a small quantity, but strong alcohol dehydrates and induces changes in the protoplasm, and Kultschitzky thinks that, for conservation only, such fluids should be used as produce no further changes in protoplasm after it has once been fixed. As alcohol, Mueller's fluid and other fluids in common use do work changes in the tissues. Kultschitzky recommends keeping preparations in either xylol, or toluol.—**National Druggist.*

QUERIES AND ANSWERS.

Under this heading, we will answer, as briefly as possible, short, concise, rational questions of subscribers, concerning bacteriology *only,* as far as our knowledge may afford.

Question. What is the best stain for bacillus of tuberculosis in sputa, from a diagnostic standpoint ?

R. M. D., Kansas City, Mo.

Answer. The following is the method of Pittion and Roux for staining bacillus tuberculosis in sputa, and is the method usually employed in our laboratory :

Sol. "A." Ten parts of fuchsine dissolved in 100 parts of absolute alcohol.

Sol. "B." Three parts liq. ammonia in 100 parts distilled water.

Sol. "C." Alcohol, 50 ; water, 30 ; nitric acid, 20 ; aniline green to saturation. To prepare the last solution, dissolve the green in the alcohol, and then add the water, and, lastly, the acid.

To use : Take of "A" one part and "B" ten parts. Heat until vapor begins to appear, then float the cover glass film down, which has been prepared in the ordinary way.

One minute will stain the bacilli, but it is well to leave longer. Then rinse with distilled water and place it in solution "C" until the red color disappears, then wash thoroughly with distilled water and mount in Xylol balsam.

It takes some practice to know just how much to discolorize. If the film of sputa is very thin, about 40 seconds in solution "C" will be sufficient.

Zuhl and Neelson's Method.—Float cover glass on carbolic fuchsine for 3-8 min. with heat. Decolorize in 25 per cent. HNO_3, or H_2SO_4, then treat with 60 per cent. alcohol until only a rosy tint remains, then wash completely with dist. H_2O and mount in Xylol balsam.

These are the two methods that we have had the best success with, and, of the two, I prefer the former.

There is a special, prepared stain, with directions on the bottle, known as "Burrill's Stain." This stain and method are excellent, but require a longer time.

Q. In your lesson in January number, you say that there is no spontaneous generation, but is there no such thing as sudden, new growth of living forms?

J. T. B., Little Rock, Ark.

A. I mean that there never occurs spontaneous generation, or spontaneous springing into existence, of anything endowed with life, except as generated by previously living beings.

Q. I heard a discussion some time since, to the effect that Koch was not the discoverer of the contagiousness of tuberculosis. Is that a fact? If it is a fact, who was the discoverer? I wish you would kindly inform me.

P. T., Hot Springs, Ark.

A. From all I can gather, Villemin, of Paris, was the first man to demonstrate the contagiousness of tuberculosis. It was in 1865. But Laennec, in 1826, had noticed its inoculability by the accidental inoculation of the disease in his own hands in dissecting. Koch later, in 1882, discovered the germ to which contagion is due.

Q. Seeing that you are practically interested in germs of disease, will you kindly tell me what system of filter is best to exclude them from drinking water?

A. So far as my experience goes, the system Pasteur-Chamberland has all the qualities desirable. There may be others on the same principle equally good. The Pasteur-Chamberland filter is on the market, and there is an agency in St. Louis.

Q. Since you give lessons in bacteriology in the BACTERIOLOGICAL WORLD, please tell me the best microscope to purchase for the study of bacteria.

P. D., Kansas City, Mo.

A. This is a delicate question, which we can answer only by past experience. In our laboratory, we use the foreign makes of Zeiss and Lietz, and the American instruments of Bausch and Lomb, and of Queen & Co. All these manufacturers make splendid instruments, and we are much pleased with each of our instruments. There are, however, other excellent American or foreign microscopes in the country with claims to superiority, but, not having had experience with them, we cannot give an opinion. Write for catalogues to the manufacturers or dealers, and get a description. As a rule, full explanations are given in them. See our advertisements.

Immersion lens (oil in preference) are necessary.

Q. I have read clippings and notices of Erlich's test for typhoid fever, but cannot find any full explanation of the subject. Will you kindly publish all information necessary for a practitioner ?

A. We cannot answer this question as clearly and as fully in writing the reply ourselves as we can in publishing the excellent article of Dr. Simon, borrowed from the November number of the *Johns Hopkins Hospital Bulletin,* and which appears in March number.

Q. Please advise me how to stain actinomyces. I have tried several ways without result. V. S., Indiana.

A. In the first place, you will be disappointed if you expect to find the beautiful, regular, pear-shaped *fungi* joined in star fashion, which you may have noticed in certain books. The new methods of staining have revealed a more complete, and different, appearance. The actinomyces is a parasite, formed by a club-shaped body terminating in a fine filament. It is somewhat like a whip with a short, stout handle and rounded, swelled butt. The butt end is usually encapsuled with a kind of cap, making its appearance still larger. In pus, the filaments and cap may be separated from one another, and may be stained separately. The finer, filamentous extremities stain blue or violet, and the encapsuled end stains red, as does, also, the cap itself, when separate. The *fungi* are usually arranged in rosette fashion, with the long extremity outward, and the filamentous extremities forming a dense, mycelial network centrally. But they may be free, or in groups of only two, four or five. It depends much on the source of the parasite. The filamentous extremity colors fairly by Gram's method, and the larger extremity by saffranine or eosine.

Saffranine is prepared by Babes' method as follows : Make a saturated aqueous solution over heat, mix to 5 per cent. of aniline, and filter through a damp filter.

Pus is spread on a cover glass in the usual way, dried, placed in this bath for several hours, and then treated with the iodized solution, clarified by aniline oil, and mounted in balsam.

This will color only the encapsuled head and the largest portion of the immediately-following filament. In coloring first the preparation with methyl violet and aniline blue by Gram's method, and then stain with eosine, both the finest central ramifications and the largest portions may be revealed, showing the connection between the two.

The same methods are applicable to both pus and sections. A long practice is necessary to succeed fairly.

FORMULAS.

UNNA'S TREATMENT FOR RED NOSE.

When red nose is due to acne rosacea Unna gives ichthyol internally in doses of 5 grains, and prescribes at the same time lotions of the same substance in aqueous solution. At night, the following paste is applied to the affected organ :

℞	Sulphur	ʒ. ss.
	Rice powder	℈ iv.
	Ointment of zinc oxide	ʒ v.

Mix, and make a pomade.

If the patient is scrofulous or debilitated, he also orders codliver oil, syrup of iodide of iron, etc.

TREATMENT OF SYPHILITIC ULCERATIONS.

Plumert gives the following applications for ulcers of syphilitic origin :

℞	Mercury salicylate	gr. xv.
	Potassium carbonate	gr. xv.
	Distilled water	℥ vi.

M. Dissolve. Sig. : Wet compresses with this solution and apply to the ulcerations.

If an ointment is preferred, recurrence may be had to the following :

℞	Mercury salicylate	gr. xvj.
	Vaselin	℥ j.

Mix and make a pomade.

IODIDE OF POTASSIUM IN GONORRHŒAL RHEUMATISM.

Rubinstein strongly recommends (in the *Therapeutische Monatshefte*) the treatment of arthrites and inflammations of the mucous bursæ with potassium iodide after the following formula:

℞ Potassium iodide . . . . ℈ iv.
Distilled water . . . . ℥ v.

Mix and dissolve. Sig.: Tablespoonful every hour for two or three days.

Amelioration usually begins after three or four doses. Rubinstein reports fifteen cases of acute and subacute gonorrhœal rheumatism treated in this manner with the happiest results.—*National Druggist.*

ULCERATIVE TONSILITIS.

A favorite prescription of Dr. Wm. G. Moore, Prof. of the Principles and Practice of Medicine, Beaumont Hospital Medical College, St. Louis:

℞ Katharmon . . . . ℥ i.
Sat. Sal. acid boracic . . . .
Glycerine, aa. . . . . ℥ i.

M. Sig.: A teaspoonful in a wineglassful of hot water as a gargle in ulcerative tonsilitis and pharyngeal catarrh.

Wm. G. Moore, M. D.

SHANCROIDS AND ULCERATIONS.

℞ Aristol . . . . ʒ j.
Tarro-Petrolene (Petr. Comp. No. 1) . ℥ ij.

Ft. ung.

Sig.: Apply twice daily.

Oz. Paquin, M. D.

LABORATORY REPORTS.

PASTEUR INSTITUTE, PARIS.

PERSONS TREATED WHO BECAME RABID DURING TREATMENT.

Volvendey (12 years old; of Beni-Saf, Algeria). Was bitten by a dog, August 28, 1890, on the lower lip which carries two deep wounds, and on the left cheek, on which we count many superficial bites. None of these wounds have been cauterized. The animal was pronounced mad by Mr. Gorce, veterinarian.

Volvendey was placed under treatment, September 7 (nine days after he was bitten). The first signs of madness showed themselves September 24. He succumbed at the Necker Hospital September 28.

Domenech, Jean (7 years old; at Ille, Pyrenees-Orientales). Bitten by a dog September 6; first, on the right cheek, which made seven wounds, of which two were very deep; second, on the upper lip (a deep wound); third, on the left superciliary arch (a deep wound). The animal was pronounced mad by Mr. Volete, veterinarian of Perpignan.

Treatment was begun September 10. Domenech took rabies September 28, he succumbed at the Children's Hospital October 2.

Vidalou, Sebastian (45 years old; at Ille). Bitten by the same dog as the preceding, September 6: First, in the nose, which made a deep wound and many other superficial ones; second, on the upper lip, a wound penetrating into the mucous membrane; third, on the left arm, two deep wounds situated about the middle; the clothes were torn.

Treatment was begun September 10. Vidalou took rabies September 20, and succumbed at the Necker Hospital October 3.

The cauterization of the wounds was made with a red-hot iron 56 hours after the biting.

Three other persons bitten by the same dog, very seriously on the face, were treated and are in good health.—*Annales de l'Institut Pasteur.*

PASTEUR INSTITUTE.

STATISTICS OF THE PREVENTIVE TREATMENT OF HYDROPHOBIA—SEPTEMBER, 1890.

		A		B		C	
Wounds of the head and face	simple	..	3	..	6	..	..
	multiple	..	1	..	2	..	..
Effective cauterization		1	..	..	..	..	..
Ineffective cauterization		1	..	2	..	..	..
Not cauterized		2	..	6	..	..	..
Wounds of the hands	simple	..	4	..	23	..	5
	multiple	..	8	..	20	..	7
Effective cauterization		..	..	1	..	2	..
Ineffective cauterization		5	..	24	..	4	..
Not cauterized		7	..	18	..	6	..
Wounds of the limbs and trunk	simple	..	2	..	19	..	6
	multiple	..	4	..	20	..	7
Effective cauterization		..	.	4	..	1	..
Ineffective cauterization		4	..	16	..	8	..
Not cauterized		2	..	19	..	4	..
Clothes torn		6	..	30	..	11	..
Bites on naked skin		..	..	9	..	2	..
Multiple wounds in different parts of the body		..	2	..	..	..	2
Effective cauterization		..	..	..	..	..	..
Ineffective cauterization		..	..	..	..	1	..
Not cauterized		2	..	..	1	1	..
Clothes torn		1	..	..	..	1	..
Bites on naked skin		2	..	..	..	2	..
Total...	French and Algeriens	..	24	..	78	..	21
	Strangers	..	..	..	12	..	6

Grand total, 141.

Column A means the persons bitten by animals with hydrophobia and recognized experimentally ; column B, those bitten by mad animals and recognized by the examination of a veterinarian ; column C, the persons bitten by animals suspected to be mad.

The biting animals were : dogs, 123 times ; cats, 16 times ; donkeys, 2 times.—*Annales de l'Institut Pasteur.*

REMEDIES AND CLINICAL NOTES.

Beech wood creasote in tuberculosis.—This drug has recently taken the front rank as a remedy for tuberculosis. It certainly has achieved considerable reputation in that direction, and numerous investigators are watching its administration with great interest. A formula for its administration :

℞	Creasote	gr. xx.
	Alcohol	ʒ vi.
	Cinnamon Water	℥ iii.
	Syrup	ʒ vi.

M. Sig.: Teaspoonful three times a day.

Diphtheria.—Dr. Slagle, in *N. W. Lancet,* says: My treatment for the past three years, which has yielded such satisfactory results, has been as follows :

℞	Calomel	gr. xii.
	Soda Carbonate	gr. xxxvi.

M. ft. chart No. 12 (or half this if young child).
Sig.: A powder every two hours.

To be followed (when all used) by

℞	Ol. Ricini	ʒ i.
	Ol. Terebinth	ʒ i.

And every alternate hour, and until the case is fairly convalescing, give a teaspoonful of a saturated solution of Merck's sulphite of sodium ; if the case is a bad one, direct a gargle or spray of the same to the throat every two hours.

I do not claim that this is all the treatment that I now ever give for diphtheria, but I do say that this is the main and principal treatment, and upon which I confidently rely for specific effects in removing the membraneous deposit from the fauces and preventing its reformation, often seeming to really abort the attack. My cases have all been fairly convalescing within three or four days on this treatment, with, of course, good support and that improved hygiene and regimen now well understood by every physician of ordinary ability.

Aristol.—Aristol, a substitute for iodoform—have you used it ? It is a compound of iodine and thymol. I have used it successfully in ulcerations, and have concluded that it is in many respects superior to iodoform, and when its action is fully understood will supplant iodoform in dermatological practice, and also in other conditions where indications call for the drug.

Aristol is harmless ; no toxic effects are observed from its use. It is no doubt a powerful parasiticide, and in ulcerations of all kinds curative effects are more rapidly obtained than with iodoform or any other drug we have ever used. In diseases of the skin results from its use have been prompt and satisfactory in every respect. In eczema, herpes, psoriasis, varicose ulcers, lupus, dermatitis urticaria, inpetigo, contagiosa, etc., have been cured by its use.

Aristol has the therapeutic properties of iodoform without its disagreeable odor and toxic effects. I use it as an ointment in vaseline—ten to twenty grains to vaseline, one ounce. It readily adheres to the skin. I frequently use it in the form of a powder, dusting it on ulcers, wounds, burns, etc. In ulceration of the os, or abrasions of the vagina, it has often a good effect and is excellent. It can be used as an insufflator or in a powder-blower. It is soluble in fatty oils, but must be made in the cold, as heat causes its decomposition. It is insoluble in water and glycerine, sparingly in alcohol ; soluble in ether and chloroform.

Aristol is a splendid remedy in the treatment of lupus and psoriasis. I know that in my hands it surpasses any other remedy in the cure of these two diseases. Several drugs have been recommended for lupus, etc. Chrysarobin has been highly lauded for this purpose. Aristol is superior, and does not stain or discolor the skin, and cures more promptly. A good formula is this : Aristol, ten parts, olive or almond oil, sweet, twenty parts, lanolin one hundred parts ; dissolve the aristol in the oil and mix with the lanolin. Bougies can be made with cocoa butter and two to ten grains of aristol. Pessaries can also be made in the same way for vagina or rectum to contain five to twenty grains of aristol.—*Medical Summary*.

IODO-CARVACROL, A NEW ANTISEPTIC.—Carvacrol is an isomer of thymol, and is formed from carvol which is found in oil of dill, oil of caraway and oil of mentha crispa. It will be remembered (*Circular* for June, 1890, page 130) that a substitution product is formed from thymol on treating it with iodine and potassium iodide in the presence of an alkali, to which the name aristol has been given. On treating carvacrol in solution with iodine and potassium iodide and rendering alkaline, a yellow precipitate is formed which is analogous in composition to aristol save for the substitution of the carvacrol for the thymol. The new compound is described (*Chem. Zeit.*) as occurring in the form of a yellow-brown powder, which is insoluble in water, difficultly soluble in alcohol, and easily soluble in ether, chloroform and olive oil. It is unaltered by light, and when heated in a capillary tube softens at 50° C., and melts at about 90° C. to a brown liquid. From its composition it would seem to be probably available for somewhat the same purposes as aristol.—*Druggist Circular*.

ITEMS ON PUBLICATIONS AND OTHER MATTERS.

THE STORY OF BACTERIA.

BY T. MITCHELL PRUDDEN.

This is an admirable, concise, compact exposition of the life, nature, properties and various special actions of bacteria. It is written clearly, plainly, and to the point; every word having weight, and adding interest. It is just the work for all who are not versed in technicalities, and adds greatly to the library of medical men in general. General practitioners, particularly those remote from centers of medical education, could scarcely find any publication so well fitted to give in few chapters the most important part of the history of bacteria to the present date.

DUST AND ITS DANGERS.

Under this title, the same author has just issued, in the same plain, concise language, another interesting little volume, showing the dangers of germ-laden dust in and out doors.

The dissemination of bacteria in the air, their relative quantities, their action in the air passages, and, finally, the dangers of contracting consumption from the germs accidentally floating here and there, are graphically explained.

It is a work that explains forcibly, in few words, and in language that will be plain to the unscientific, the hygienic principles that they may put in practice with much benefit. The physician, too, and even the scientific man will find much useful information. It is well illustrated.

These two little books contain in a nutshell the most important part of the properties and history of bacteria.

QUEEN'S OIL IMMERSION LENS IN PHOTO-MICROGRAPHY.

We received some magnificent and clear photographs, made with one-fifteenth "Queen's oil immersion," by F. E. Ives and Dr. H. J. Detmers, of Ohio, whose reputation in this line of work is national. They represent the bacillus of anthrax at 1,000; the bacillus of typhoid fever at 1,000; the bacillus of tuberculosis at 800, and amph. pellucida, lines 98,000 per inch, power 1,050 diameters. The latter was made by lamplight.

These photographs are among the finest it has ever been our fortune to see, and speak well for the lens and the operators.

LA CLINIQUE.

This medical periodical appears in a new and very neat dress in its first number for '91. It is quite an improvement on the old, both in style, color and fitness, and the magazine itself has made a step in advance.

May the soul of this journal always prove as interesting to the mind as its ornament is pleasing to the eye.

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EDITORIAL.

STILL ANOTHER REMEDY FOR CONSUMPTION.

Germany brings forth another discovery of an agent said to be remedial in tuberculosis. Prof. Liebreich is the discoverer. Drs. Fraenkel and Herman have experimented with it, and their results seem to indicate some therapeutical value.

The remedy consists of "cantharidate of potash"; it is administered by injection under the skin in very small doses, and its action seems to depend on an increase of transudation of serum (which we know is bactericide) and nourishing principles into the diseased tissues. Beginning with one-fiftieth of a milligram, the doses were gradually increased, during the experiments, to six milligrams; the average quantity used, however, is two milligrams.

Dr. Heinemann gave the history of a number of cases of tuberculosis, some of them bad, which had been successfully treated. Hæmaturia appeared in certain cases after the injection, but Liebreich did not consider this pathological phenomenon of much consequence, in view of the ultimate benefits to be derived in consumption. Trials are being made in cases of laryngeal tuberculosis and lupus of the head.

Prof. Liebreich explains that his discovery was made public prematurely under pressure of Minister Von Gossler. This is very unfortunate; the results of the premature announcement of Koch's remedy under similar pressure should, it seems to us, have taught more wisdom. Premature publicity of partly-made discoveries of such potentiality are injurious to the discoverer, the discovery itself, and only retards the benefits that may be in view, or even within reach. The people become more or less excited, are led by ignorance, confusion and intemperate print to expect too much; then, when accidents or failures occur, a depressing reaction follows, the discovery is at once classed as valueless, and the author suffers unjustly.

NATURAL ANTISEPTICS OF THE BODY.

The discovery of bactericide proteids of the animal body opens a new field of a very wide character, for the practice of curative and preventive medicine in man and beast.

It is well known that whilst certain animals are subject to a given disease others are not. For instance, cattle are liable to symptomatic anthrax (black-leg), but horses, man and certain other species are not; horses and man are subject to glanders and cattle are not; almost all animals are subject to charbon with the notable exception of rats. Prof. Hankin, being admitted into Koch's laboratory, was waiting in vain for an opportunity to learn the methods to prepare Koch's lymph. In the meantime he busied himself studying anthrax, a disease which had occupied his mind for some time. His first step was to find the reason for the natural immunity of rats against this disease. In this he was rewarded to the fullest extent.

He found that the body of rats contains a *natural protective protein* matter which kills the baccillus of anthrax, or at least prevents its growth. He succeeded in isolating this substance by making a glycerinated extract of spleen from rats, and precipitating it afterwards with alcohol; the protein is then soluble in water. The most minute doses, injected into mice suffering from anthrax, were sufficient to cause recovery from the most virulent form.

In the calmest contemplation of this discovery, we must admit that it is extremely full of possibilities of the greatest magnitude. Almost every bacterial disease, if not all of them, find animals in which they have no effect, and "do not take."

Mr. Hankin had some time ago announced the discovery of these natural protective substances; now he has begun the practical application of them. It needs little thought, and no long discourse on anyone's part, to bring to one's mind the vastness of this achievement.

Tuberculosis itself is a disease that some animals do not contract! So is Texas fever, in our country; so is so-called *mad-itch* in cattle; swine plague, etc., etc. Besides that, it is a great step in advance in the settlement of the question of natural and acquired immunity.

TREATMENT OF PULMONARY CONSUMPTION IN COLORADO.

The *Sanitarian,* one of our most useful and worthy exchanges, publishes, in its February number, an exhaustive and very interesting article on the above subject, from the pen of S. Edwin Solly, M. D., M. R. C. S. It is a presentation of the history, treatment and results obtained in 141 cases of pulmonary tuberculosis in the climate of Colorado (Colorado Springs). It shows that tuberculosis is curable, under proper climatic influences without any of the new discoveries; unfortunately only a very small percentage of tuberculous people are able to visit this healthy climate. Physicians and the public would do well to read this excellent and instructive report. The results in those 141 cases are as follows:

FIRST STAGE.

62 cases	Cured	36=58.04	per cent.	Improved, 54=87.09 per cent.
	G. Improved*.	14=22.93	“	
	Improved	4= 6.45	“	
	Worse	1= 1.61	“	Worse, 8=12.90 per cent.
	Death	7=11.29	“	

SECOND AND THIRD STAGES.

79 cases	Cured	11=13.92	per cent.	Improved, 41=51.89 per cent.
	G. Improved*.	14=17.72	“	
	Improved	16=20.25	“	
	Worse	2= 2.53	“	Worse, 38=48.10 per cent.
	Death	36=45.56	“	

TOTALS.

141 cases	Cured	47=33.33	per cent.	Improved, 95=67.37 per cent.
	G. Improved*.	28=12.76	“	
	Improved	20=14.11	“	
	Worse	3= 2.12	“	Worse, 46=32.62 per cent.
	Death	43=34.96	“	

*Greatly improved.

GANGRENE OF THE LEG CONSECUTIVE TO ERYSIPELAS OF THE FACE.

M. Reynier, before the Academy of Medicine, Paris, January 21, reported an interesting case of gangrene following erysipelas, which suggests modification as to time of interference in complications of this type.

A young soldier, on the sixth of November last, presented "serious general symptoms, profuse sweating, diarrhœa, fever, followed after a few days by an adeno-phlegmon in the submaxillary region." During the month of December the left leg and foot were invaded by gangrene. In a few days the separation of the dead parts from the live tissues began, and Larry's amputation was practiced under the knee.

The result seemed very good, but suddenly, a few days after the operation, the patient presented symptoms of a double *infectious* pneumonia, and nervous phenomena of the *same* nature.

The moral of these rare complications seems to be earlier operation.

THE MICROBE OF EPIDEMIC CEREBRO-SPINAL MENINGITIS.

Dr. Bonome investigated an outbreak of cerebro-spinal meningitis in Padua, and claims that he discovered a special micro-organism which is the specific cause of it. It is a *streptococcus,* differing morphologically from the various pathogenic cocci of this class, found by Nicolaier, Guarnieri, Lœffler and Weichselbaum; it also differs in its preferences, in cultures and inoculation in small animals.

Further investigations are necessary to verify these observations.

INJECTION OF BLOOD SERUM OF THE DOG INTO THE TRACHEA AS A TREATMENT OF TUBERCULOSIS.

Dr. Saint-Hilaire and Dr. Coupard, before the Society of Biology of Paris, January 31, gave the effect of intra-tracheal injections of blood serum as a treatment of tuberculosis. It had been discovered that blood serum raw was microbicide, and that its effect on the bacillus tuberculosis was in harmony with this discovery.

Saint-Hilaire and his colleague began experiments with the view of finding the most inoffensive, less objectionable and yet the most absorbable channel for introduction and reception of the blood serum of the dog. In rabbits, dogs and man, in all of which intra-tracheal injections were made, the operation proved entirely inoffensive. Four cc. of serum were introduced at six different times in a man of twenty-two years of age, suffering from pulmonary and laryngeal tuberculosis, and no ill effects resulted; not even a cough nor embarrassment in respiration.

The results of these injections have been so far to improve the general condition of the patients notably, and, even, the cure of a laryngeal case. It is to be hoped that this simple treatment may prove beneficial.

ACTION OF BACTERIAL PRODUCTS ON INFLAMMATION.

In the course of 1890, Messrs. Charrin and Gamaleia sent a note to the Academy of Paris, calling attention to the property of certain microbe products in modifying inflammation. Certain experiments since bring the question back to us, and we, therefore, give the substance of this note.

Buchner and Bouchard have established that, in the majority of cases, the intensity of the local lesion due to bacteria is proportional to the resistance of the inoculated animal. The richness of this local lesion is furthermore usually due directly to this animal resistance excepting in cases of absolute vaccination.

With the view of explaining the presence or absence of the leucocytes, according to the state of immunity or receptivity, scientific men have thought that in the first case the white corpuscles were attracted by the bacterial secretions, or became accustomed to their action,—action which in the second case repulsed or paralyzed them.

Mr. Bouchard had demonstrated that the injection of soluble products of some bacteria prevented diapedesis; it restrained the migration of the leucocytes from the blood vessels. The following facts sustain this observation:

If croton oil is rubbed on a rabbit's ear, redness and swelling occur within about four hours, and within eight hours considerable exudation and even blisters may be present. But if, after this oil friction, 4cc. to 8cc. of a sterilized liquid pyocyanic culture are injected every two hours until four or five or six injections are made, the symptoms above enumerated do not appear unless it be the next day in case the inoculation had to be discontinued because of their poisoning effects on the general system.

We see that secretions of certain pathogenic agents may act on inflammation as a whole, prevent the congestion, the plasmatic transudations, and stop diapedesis.

Investigations are now in progress with the object of deciding whether these agents act directly on the blood vessels, or through the intermediary of the nerves; and also to find what other microbes, if any, secrete substances with such remarkable properties on inflammation.

PAUL GIBIER, M. D.

We have the pleasure to present with this issue an excellent likeness of one of our collaborators, Paul Gibier, M. D. (of the University of Paris), formerly interne of the hospitals of Paris; assistant in pathology in the Paris Museum; now director of the New York Pasteur Institute.

This gentleman is one of the foremost bacteriologists of our time, and has achieved fame by knowledge and hard work. He has contributed a great deal to medical science since the year 1880.

In 1884 he was intrusted by the French government with the study of cholera in France. In 1885, the same government sent him to Germany to study the nature of the bacteriological laboratories of the German Empire. In the same year he was sent to Spain to study cholera. In 1887 and 1888 he went in mission to Havana to study yellow fever.

His numerous publications have appeared in French, Spanish and English. We refer our readers to notices and items in this magazine for the nature of the literature of which Dr. Gibier is author.

THE BACTERIOLOGICAL WORLD.

It is our aim to make this publication as useful, interesting and as worthy in every respect as a magazine of its character can be. For the accomplishment of this purpose, we very earnestly request original contributions from those in authority to speak on the subject of bacteriology.

The BACTERIOLOGICAL WORLD circulates in every state, and in almost every territory in the union. It reaches, besides, Canada, and all European countries where any attention is paid to the question of which it treats.

Writers, therefore, through this medium, may present their best thoughts, the results of their investigations, and their experience, to more widely scattered scientific and professional readers than through any medium of analogous order on the continent.

LESSONS IN BACTERIOLOGY.

LESSON THIRD.—PART I.

PHENOMENA ACCOMPANYING NUTRITION AND VEGETATION OF BACTERIA.

We have seen that bacteria reproduce their like by spore formation and by fission. Let us now examine into their growth more closely.

The spores, in relation to the adult bacteria producing them, are, as the grains of wheat in relation to the wheat plant itself; as the apple seeds in relation to the apple tree; the grape seeds in relation to the grape vine. In either case they represent the last resort of nature to reproduce the species. An apple tree may, however, be reproduced by grafting a branch on another tree; a vine may be reproduced by planting a piece of stalk into the earth; but these methods are not so natural as the forming and germination of seeds.

In bacteria, however, the formation of spores and segmentation seem equally natural to the being in certain circumstances. Multiplication by fission occurs whilst there is nourishment, and the formation of spores, in the micro-organisms in which it has been observed, takes place chiefly when their nourishment is becoming exhausted; then, bacteria form these seeds for the preservation of their kind, for the spores have more power of resistance than their producers. They are capable of germinating the moment they are generated, providing that they come in contact, at a proper temperature, with nutritive material that they can utilize and assimilate. But, when these conditions do not exist, they dry up, and may resist influences that would totally destroy their generators. For instance, if the spores of the bacillus of anthrax are kept in a dry atmosphere, they will retain their germinating power for years, as some seeds of large plants in the same condition may. On the contrary, if kept in moisture, warmth, and in contact with material from which they can extract nutrition, they will germinate, form new bacilli, which in their turn may throw off spores.

Therefore, schizomycetes may keep their species in the universe by forming spores which may resist for a long time the various influences tending to destroy the species themselves. The surroundings and external influences to which the spores may resist vary a great deal. A spore may for a time, without growing, preserve its property of germination in the earth, water free from alimentary substance, and in various other things perhaps as well as in a dried condition. If any amount of nourishment exists, and the temperature is favorable, they vegetate, eat that up, and then the new individuals may form new spores. Certain disease germs are thus preserved and propagated.

The spores resist a variable amount of heat, but all of them retain their vital energy in presence of much higher temperature than the bacteria. Thus the temperature of 212° F., boiling point, destroys in a few minutes the great mass, if not all kinds, of micro-organisms, but it takes more heat and a very much longer time at boiling temperature to kill their spores. Of course, the duration of the exposure to heat has a great deal to do with this destruction. 212° F. must eventually kill even the most resisting spores kept at this temperature a very long period, but I mean that whilst this degree of heat may kill a given germ in five minutes, say, it would likely require a half hour or more to kill its spores; indeed, some resist 212° several hours.

Experiments have demonstrated that in water and nutrient solutions, spores are killed in five to fifteen minutes at a temperature between 250° and 262° F. In a solution of glycerine, a temperature of forty or fifty degrees less, sometimes destroys their germinating power.

On the other hand, freezing temperature is not sufficient to kill the germs (or at least the great majority of them), or their spores. Ice often contains living bacteria in abundance but usually they are in spore forms except in case of cocci.

The most favorable temperature for the growth of most of bacteria seems to be between 86° and 104° F. At a higher or lower temperature, their vegetation and the formation of spores diminishes as the temperature increases or decreases, until all vegetation phenomena are arrested.

Microbes, notwithstanding their minuteness, have a very complicated substance. Their constituting material, analyzed chemically, is found to contain carbon, oxygen, hydrogen, nitrogen and various mineral salts. Hence, they need nutrition that can supply these matters.

The most suitable media of nutrition are vegetable and animal infusions, or broths. Thus it is apparent that albumenoid matters constitute proper food for the microbes. Nevertheless, some germs at least, may live and vegetate at the expense of other matters, purely mineral salts of known composition. Pasteur succeeded in developing the yeast plant (*torula cerevisiæ*) in a media free from any kind of albumenoids. It is thus that he defeated Liebig's theory of fermentation. This great savant contended that fermentation depended on the destruction of the protoplasm of organized substances.

Every process of vegetation has fixed limits of temperature beyond and below which growth is arrested. This is just as true of bacteria as it is in the case of other organisms. Bacteria, in this respect, are as subject to fixed rules as are all other living things. Transgression of these limits may lead to destruction of the transgressors or temporary impairment of their vital energy.

The bacteria being probably all plants, though there still exists some doubt about some of the microbes as I said in the first lesson, nourish themselves as vegetables. But being, as the fungi, deprived of chlorophyl, they cannot decompose carbon dioxide any more than the latter. The plants, with green substance, chlorophyl, operate thereby this kind of decomposition to nourish themselves, *i. e.*, to extract and appropriate carbon. The fungi and bacteria must both obtain their carbon by utilizing organic carbon compounds already formed in other bodies. This is the case in all organisms deprived of chlorophyl.

The thallophytes then, to which series of organisms the bacteria belong, can take up their nourishment only in a fluid or gaseous condition; when they come in contact with nutritive substances they produce a transformation by means of diastases which brings about assimilable matters; they find thus the means of nourishment.

A few bacteria contain a green substance which is thought by some authors to be chlorophyl. If this is the case, it is to be assumed that this particular kind is capable of decomposing carbon dioxide. It is needless to say that there is a change brought about in the material at the expense of which microbes exist; all points to the universal physiological law of assimilation and nutrition ; viz. : *First,* the transformation of matter, non-assimilable as such, into assimilable substances ; *second,* a process of respiration of some kind, either intramolecular, or by exhalation of more or less oxygen.

All kinds of beings have their tastes and preferences for food. The fungi develop better in slightly acid substances ; the bacteria prefer slightly alkaline or neutral nourishment.

According to their nutritive *adaptation,* bacteria are divided as follows : *First, parasites,* consisting of organisms feeding on living plants or animals ; *second, saprophytes,* microbes feeding on dead organic substances. But there are micro-organisms which go normally through their course of life as saprophytes, and have *also the power* of feeding partly or wholly as parasites ; these are termed *facultative parasites.* On the other hand, certain parasites, which normally exist as such, have also *the property* of living on dead organic matter ; these are termed *facultative saprophytes.* They are intermediate classes graded between the two extremes.

PART II.

DIASTASES.

Part of what we have just seen proves that all the substances forming higher organizations enter into the constitution of bacteria, and our studies so far tend to show that nutrition depends, throughout the species of both (or all) kingdoms, on some process of digestion, respiration and assimilation governed by unalterable laws of nature.

We have seen, too, in the beginning and in the course of our inquiries, that the first necessity is the digestion of food, within or without the organism, and that probably all beings may, for this purpose, secrete one or more substances capable of producing the changes required to render the food assimilable.

We are given to understand that man, and I may say all complex *animals*, digest the solid and some of the fluid food swallowed before they can appropriate any of it to nourish their tissues; such is for instance the object of the diastase secreted in the stomach, pepsin. We have seen that complex *plants* may secrete diastases for the purpose of digesting, at certain periods, some inassimilable nourishment stored away in some parts of the vegetables for a special use, such as the sugar in the roots of the beet, which remains insoluble until the time of flowering, when a secretion occurs within the beet root which transforms this sugar into an assimilable kind, and the plant absorbs and utilizes it. We have seen further that microbes have the same power. Let us now investigate the question of diastases a little more fully.

Amylase is the name (in French) of a diastase which in the vegetable world digests starch, *i. e.,* it has amylolytic properties. This substance is secreted in a grain of corn (and some other grains) in process of swelling and germinating, under the influence of heat, moisture, etc., permitting the latent vital energies to develop. This diastase then gradually dissolves the starch at the expense of which the corn plant, at first embryonic, nourishes itself under proper conditions, until it has grown and acquired sufficient energy, *i. e.,* physiological powers to begin the extraction of nourishment from its surroundings.

Here is a clear process of digestion of starch by a plant before assimilation. Now, in animals what digests the starch of corn before its assimilation? It cannot be utilized as such. It is a diastase, that also has amylolytic properties, and which is secreted by the pancreas.

If, now, microbes are fed starch, how can they assimilate any of it? By a diastase, some sort of amylase secreted by them, and this is probably the secret of the action of the saliva on starch in the mouth. The saccharine substance formed there is probably due to various microbes of the buccal cavity, or contained in or mixed with the food masticated. Pasteur thinks microbes useful in digestion. Let us consider other kinds of diastases.

Rennet ferment, trypsin, pepsin.—The first of these ferment principles exists in the stomach of the young calf in lactation to the exclusion of other digestive agents. It is this agent that causes the coagulation of milk. Gradually, as the young begins to ingest other kinds of food, this principle disappears and is replaced by *pepsin;* finally the latter alone exists. In this state the ingested milk is also coagulated in the stomach; but it is by the action of the acid in the gastric juice and not by the rennet ferment. Thus, the milk ingested curdles in the stomach, both during the period of lactation, and afterwards in all stages of life, but by the action of different agencies. (The bovine species only furnishes a fit example of the digestion of milk in mammalians.)

After this coagulation has taken place, however, neither of the diastases that produced it, in the young or adult, can act further upon the coagulum that they have formed respectively. This coagulum passes into the intestines; there it is dissolved and rendered assimilable by the action of *trypsin.*

Pepsin, then, which in the presence of the acid in the gastric juice, acts as solvent of albuminous substance, is not capable of liquefying into an assimilable state the curd which, mixed with the gastric juice, it has brought about. Now among microbes, we find some that may nourish themselves at the expense of the caseine of milk just as in complex animals, and for that purpose they also secrete diastases that may be compared to the rennet ferment and the trypsin.

If, for instance, sterilized milk is inoculated with the ferment microbe known as *tyrothrix tenuis,* there is first coagulation, then a dissolution of the curd without the advent of new germs. This, at first thought, seems to indicate an action contrary to that of the digestive ferments of the milk in animals, in which the stomach ferment principles cause a coagulum which they cannot dissolve, but which must be acted on for this secondary result by the trypsin of the pancreatic juice. It is not so however. It only indicates that the microbe, being a unicellular organism, has to do everything for itself, whilst the animal in the high type mentioned is formed of cells, among which labor has been divided and specialized as we have seen before. For the digestion of milk the cells of the stomach secrete certain substances; those of the pancreas, certain others; the individual microbic cell secretes them all.

If now we consider the mass of microbes as plants, we may think it difficult to reconcile these facts with what we know of the nutrition of vegetables of a complex character. The properties of these diastases would seem to indicate animal life instead of vegetable. This is only seemingly so. Digestive ferments of this order have been found even in complex plants, such as the carnivorous kind known as *nepenthes, darlingtonia, drosera,* etc. These secrete substances capable of digesting albumenoids and even live animal beings. The plant known as *carica papaya* secretes (after Wurtz) a juice that is capable of digesting febrine in presence of an acid or in neutral media. Besides, if we recall to our minds the differences in the vegetation of large plants and thallophytes, owing to the presence of chlorophyl and specialization of labor in the cells of the former, and the absence of chlorophyl and the unicellular organization of the latter, we shall see further explanations of the *role* of these diastases in bacteria considered as vegetables. Indeed, by a close study of the processes of nourishment of all kinds of living beings, no matter to what kingdom they belong, we may harmonize the apparently inconsistent discoveries and facts concerning their respective properties.

PART III.

FERMENTATION.

Mr. Duclaux admirably defines fermentations in the following words: "Chemical transformations of substances dissolved under the influences of organized beings, always deprived of chlorophyl, which develop and live in the interior of the liquid which ferments." This refers, seemingly, particularly to the well-known and common phenomena of fermentation in liquid substances; however, such transformations take place in semi-fluid substances, and in more or less solid matters, but the changes in these were not supposed to be varieties of fermentation until the special properties of bacteria were clearly demonstrated.

In the study of fermentation, Pasteur discovered that bacteria differ greatly in regard to their respective want of oxygen. Everything else being equal, he found at one end of the scale, microbes that are favored in the highest degree by the greatest amount possible of atmospheric air containing free oxygen. Such is the case, for instance, with the *bacillus subtilis,* which grows so well in open air, in hay infusions, etc.; at the other extremity, he found some favored by the exclusion of free oxygen; such is the *bacillus butyricus,* which may develop in the very center of a mass of butter, and produce butyric acid, which, with other elements, contributes to produce rancidity in butter. The first kind has been termed, therefore, *aerobiotic;* the second, *anaerobiotic.*

Between these two extremes, there are some requiring less pressure of oxygen than that afforded by atmospheric air. According to Nageli, the aerobiotic forms may also vegetate without free oxygen. Thus it would seem that this division of bacteria into aerobiotic and anaerobiotic is not absolute or defined by a clear line.

It is not our province to study all the phenomena of various fermentations here, but it is well to understand the most important ones. Therefore, we will touch on one or two more; namely, the production of heat and certain results of fermentation. In our study of the nutrition of microbes, we have glanced at most of the other interesting ones.

During the processes of fermentation, there is produced more or less heat. Everyone knows of the high temperature created in a manure heap, vegetables in a silo, or a stack of hay in fermentation; it sometimes rises sufficiently high to consume to ashes, or even cause spontaneous combustion. "Fermentation," says Cornil and Babes, "is a sort of intramolecular respiration of the schizomycetes. The chemical reaction resulting then produces heat which is also necessary for the development and multiplication in the fermentescible matter." Robin has well explained that they are "particular cases of nutrition, chemical nutritive acts, with production of heat as in most of such acts."

Still, whether we consider fermentation from a botanical or chemical standpoint, everything is not absolutely clear, and it is possible that future investigations will modify the views now prevalent among naturalists, as to what individuals may be properly termed ferment-producing agents. But we have a mass of facts, proving at least the result of the existence of various microbes at the expense of fermentable substances, viz., transformation. One result of fermentation, or chemical transformation, brought about by the nutritive processes of micro-organisms, is important to know from a pathological standpoint above all others, that is, the possible *death* of the ferment agents themselves in their own products, poisoning in their own effete matter. Thus, in alcoholic fermentation, the schizomycetes causing it, yeast plant and others, are intercepted in their vegetation when the alcohol produced in the media in which they live has reached about 17 per cent.; the quantity of alcohol seems to constitute their poison. In the fermentation of wines in sealed vessels, fermentation stops thus by itself. If, on the contrary, this fermentation is allowed in the air, the surface will soon be covered by another organism which transforms the alcohol generated by the preceding germ into water and carbonic acid ; this organism is the *mycoderma vini*, which burns the alcohol and transforms it into vinegar. A succession of microbic lives may thus exist and die in a given media, the first forming material fit, in a measure, for the nourishment of the second, the second for the third, etc. In these alcoholic and acetic fermentations, the first organisms acting were anaerobiotic ; the alcohol resulted from yeast plants living at the bottom of the fermentescible matter, at a remote distance from the free oxygen of the atmospheric air ; the second or third forms that succeeded to the dead alcohol producers were aerobiotic, and lived on the surface, in contact with free oxygen.

In pathology we find bacteria of the same aerobiotic and anaerobiotic classes. The bacillus of anthrax (charbon), for instance, belongs to the former kind, and that of symptomatic anthrax (black-leg) to the latter. In the cultivation of disease germs, we find, too, that they may be killed by poisons produced by themselves, and that different kinds of bacteria may succeed each other in the midst, and partly at the expense of the products of preceding ones.

PUTREFACTION.—The transformation of dead bodies of all kinds does not depend solely on one kind of germ but on several. The *bacterium termo,* whilst it seemingly plays the most extensive and most important part in the decomposition of animal bodies, has many associates in its life. Consequently, the phenomena known as putrefaction consist of the whole of the transformations; putrefaction, in a word, is the sum total of the results of the nutrition of micro-organisms at the expense of dead vegetables and animals. In these phenomena "sugar is transformed into lactic acid, mannite, dextrine, glycerine, butyric acid, mucilage, etc. Alcohol is transformed into acetic acid, urea into carbonate of ammonia, albumen into peptone, or other similar substances. There also are generated, the putrid poisonous substance named sepsine; the septic alcaloids of Zulzer and Sonnenschein; the ptomaines found by Selmi, Gauthier and Breiger, etc.; certain narcotics; leucine and tyrosine; butyric, palmitic, margaric and fatty acids; volatile products, iodol, phenol, scatol, sulphurated hydrogen, ammonia, carbonic acid, water," etc., etc.

Therefore, the surface of the soil is the seat of very important changes; many needed products originate there, without which, the plants of the earth must fail to find sufficient and proper food. There, ammonia is decomposed by microbes and nitric acid is liberated; this acid in its turn may be decomposed into its formative elements or be returned to ammonia. These are the necessary phenomena of the nitrification of soils. The action of bacteria in the superficial layers of the earth is said to be indispensable for the germination of seeds therein. Duclaux found that sterilized earth is improper for germination.

SAPROGENOUS AND CHROMOGENOUS BACTERIA.—Among the putrefactive microbes, there are some whose growth is associated with nauseous or aromatic agreeable odors. These bacteria are termed *saprogenous.* We all know that gangrene, ozona, the secretions of the feet associated with the generation of certain organisms, present more or less disagreeable odors; on the other hand, Babes and Galtier have cultivated micro-organisms which presented agreeable odors.

The *chromogenous* bacteria are those which produce certain coloring matters during their vegetation. The *micrococcus prodigiosus,* for example, produces a beautiful red; the organism of green pus produces a green color. In describing each bacteria, we will refer to them more specially. These coloring matters may be separated by chemical processes, such as the action of chloroform, alcohol and ether. The action of heat, light, oxygen of the air, alters and fades these colors, and, under special conditions of nourishment, color-producing bacteria may be grown colorless. Such is the case if a little bichloride of mercury is added to the culture of the organism of blue pus. The growth of other chromogenous bacteria in similar media may also be without coloring substances.

PART IV.

PTOMAINES, LEUCOMAINES, TOXALBUMENS, BACTERIAL PROTEIDS.

Under these names enter various products resulting from the growth of bacteria.

Ptomaine is the name given to certain products of putrefaction ; chemically considered, they are found to consist of nitrogenous alkaloid bases of animal or vegetable extraction. They are probably produced both by independent bacteria, associations of bacteria, and, perhaps, some are chemical combinations of bacterial products of various kinds. Certain ptomaines are poisonous and others are not ; doubtless, products of the poisonous kind obtain greatly in various bacterial diseases more closely related to putrefaction processes, but they certainly are not as universally dangerous factors in all bacterial maladies as was once thought ; for several of the pathogenic schizomycetes differ greatly in their transformation of tissues with the bacteria of putrefaction. There is a vast difference, for instance, between the results of the decaying of the lungs of a dead body and the results of the growth of the bacillus of tuberculosis therein during life, though both are due to bacteria ; but there is not so much difference between the former phenomenon and infectious pneumonia ; and still less between the decomposition of a dead lung and a gangrenous living lung. In bacterial diseases, so closely allied to putrefactive processes, the ptomaines doubtless play an important *role* and may cause mortal poisoning. This is evidently the case in septicemia.

Other substances, yet unclassified, have been found associated with putrefactive processes, which resemble in their action such poisons as coniine, strychnine, morphine, atropine, nicotine, digitaline, veratrine, etc.; some such matters were found in cadavers. These discoveries make very doubtful chemical analysis in certain suspected cases of poisoning.

Ptomaines of a poisonous character have been found in canned meats, fish, oysters, in cheese, ice-cream, etc.

Immunity against a disease is probably not produced by ptomaines, as was supposed.

The following is a table of ptomaines, copied from Vaughan :

TABLE OF PTOMAINES (From Vaughan).

NAME	FORMULA	DISCOVERER	PHYSIOLOGICAL ACTION
Methylamine	CH_5N	....	Non poisonous
Dimethylamine	C_2H_7N	....	“
Trimethylamine	C_3H_3N	....	“
Ethylamine	C_2H_7N	....	“
Diethylamine	$C_4H_{11}N$	....	“
Triethylamine	$C_6H_{15}N$	....	“
Propylamine	C_3H_9N	....	....
Amylamine	$C_5H_{13}N$	....	....
Hexylamine	$C_6H_{15}N$	....	....
Tetanotoxine	$C_5H_{11}N$ (?)	Brieger	Poisonous
Collidine (?)	$C_8H_{11}N$	Nencki	....
Hydrocollidine (?)	$C_8H_{13}N$	Gautier and Etard	Poisonous
Parvoline (?)	$C_9H_{13}N$	“ “ “	....
Unnamed	$C_{10}H_{15}N$	Guareschi and Mosso	Poisonous
Ethylidenediamine (?)	$C_2H_8N_2$	Brieger	“
Trimethylenediamine	$C_3H_8N_2$	“	“
Putrescine	$C_4H_{12}N_2$	“	Non-poisonous (?)
Cadaverine	$C_5H_{14}N_2$	“	“ (?)
Neuridine	$C_5H_{14}N_2$	“	“
Saprine	$C_5H_6N_2$	“	“
Unnamed	$C_7H_{10}N_2$	Morin	“
Methylguanidine	$C_2H_7N_3$	Brieger	“
Unnamed	$C_{13}H_{20}N_4$	Oser	....
“	$C_{17}H_{38}N_4$	Gautier and Etard	....
Mydine	$C_8H_{11}NO$	Brieger	Non-poisonous
Neurine	$C_5H_{13}NO$	“	Poisonous
Unnamed	$C_5H_{11}NO_2$	E. & H. Salkowski	Non-poisonous
Choline	$C_5H_{15}NO_2$	Brieger	Poisonous
Betaine	$C_5H_{13}NO_3$	“	Non-poisonous
Muscarine	$C_5H_{15}NO_3$	“	Poisonous
Mydatoxine	$C_6H_{13}NO_2$	“	“
Mytilotoxine	$C_6H_{15}NO_2$	“	“
Gadinine	$C_7H_{17}NO_2$	“	Non-poisonous
Typhotoxine	$C_7H_{17}NO_2$	“	Poisonous
Unnamed	$C_7H_{17}NO_2$	“	“
“	$C_5H_{12}N_2O_2$	Pouchet	“
“	$C_{14}H_{20}N_2O_4$	Guareschi	....
Tetanine	$C_{13}H_{30}N_2O_4$	Brieger	Poisonous
Unnamed	$C_7H_{18}N_2O_6$	Pouchet	“
Tyrotoxicon	....	Vaughan	“
Mydaleine	....	Brieger	“
Spasmotoxine	....	“	“
Peptotoxine	....	“	“

Leucomaines should not be confounded with the ptomaines; they have some analogy, but are not identical. They have been defined as "basic substances found in the *living* tissues, either as the products of fermentative changes, or from retrograde metamorphosis."

Some authors think that they are generated in the intestinal canal, and absorbed as assimilable matters.

We gather, then, that they exist without disease; and that the most of them are non-poisonous.

The leucomaines have analogy either with *uric acid* or *creatinine;* for this reason they are divided into two groups bearing these names respectively. The uric acid group is composed of adenine, hypoxanthine, guanine, xanthine, heteroxanthine, paraxanthine, carmine, pseudoxanthine and spermine. The creatinine group is composed of xanthocreatinine, amphicreatinine, and three unnamed bases.

There are undetermined poisonous leucomaines in expired air, vapors exhaled by dogs, the saliva of man, the venom of poisonous snakes, urine, sewer air, etc.

If the leucomaines are some of the products of fermentative changes, as is conceded, they may, of course, be produced by pathogenic microbes in the organism and thus both ptomaines and leucomaines may exist during disease.

Bacigalupe, in making a study of immunity, came to the conclusion that it is produced by the means of leucomaines.

TOXALBUMOSE.—Roux and Yersin have discovered, in pure cultures of the bacillus of diphtheria, a poisonous substance which is neither a ptomaine nor leucomaine, but apparently a kind of diastase, capable, by itself, of *reproducing the general symptoms of the malady*. Christmas discovered that the staphylococcus aureus (a pus bacteria) generates a sort of albumenous substance, which, when introduced into the anterior chamber of the eye of a rabbit, produces pus. Hankin, in Koch's laboratory, isolated albumenous toxic substances from cultures of the bacillus of anthrax.

These substances have not been identified with true albumen, but they have some analogy with it. Hence the name of toxalbumen, which has been given to them. Cornil and Babes suggest the term of *toxalbumose,* which seems to me more proper.

Brieger and Frankel have made researches concerning toxalbumose in cultures of various pathogenic bacteria, and found two classes, viz., one soluble in water, and the other insoluble in water. The toxalbumose of tetanus, that of anthrax (charbon), and that of diphtheria are soluble in water; the toxic albumens of typhoid fever, cholera and of staphylococcus aureus are insoluble in water. The discovery of toxalbumose is a most important one; in connection with the knowledge of ptomaines and leucomaines, it advances medicine greatly towards the solution of preventive and curative treatments of many hitherto fatal, uncontrollable affections. It is probable that the so-called "Koch's lymph," for the cure of tuberculosis, is of the nature of toxalbumose.

BACTERIAL PROTEIN.—This is another active substance recently discovered in connection with bacteria. Buchner* Lauge, Roemer have demonstrated that there exists in *the body the plasma* of pathogenic bacteria, a chemical substance of protein nature, which has the property of producing disorders, and attracts the leucocytes in a marked degree.

Injected under the skin it produces a "chemical" non-infectious inflammation accompanied with lymphangitis, which resembles the inflammation of erysipelas. This substance, being in the structure of the bacteria, is active only when set free by the natural involution of the organism or by their destruction by death. Though this discovery is recent, seven kinds of proteins have already been identified. The most virulent is that of typhoid fever. They may be obtained by treating pure cultures with weak solutions of potash (0.5 to 1.5 per cent.), filtration, and then precipitations of the protein by acetic or nitric acid.

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(Fourth lesson in April number.)

ORIGINAL ARTICLES.

BACTERIA.

BY ARTHUR G. HOPKINS.

(Read before the Ontario Veterinary Medical Association, Ontario Veterinary College, January 27, 1891.)

In bringing before your notice these organisms which have so revolutionized and stimulated theories regarding disease, its cause and cure, I do so, knowing that at present our knowledge regarding them is so incomplete as to cause a number of people to be skeptical as to their presence. Before going any further it is as well to know what are bacteria.

DEFINITION.—Bacteria are little masses of protoplasm, achlorophyllous, having a membrane composed of cellulose and mycoprotein, capable of multiplying by fission, hence their name schizomycetes, and require the microscope for their detection.

HISTORY.—The first notice of them was over two hundred years ago, by Leuwenhœck, the father (?) of microscopy; he found them in saliva, putrid water, fœces, etc. No particular notice seems to have been taken of them till Mueller, in 1773 A. D., described them as animalcules (infusoria class), and divided them into monas and vibrios. The next mention of them is by Ehrenberg, in 1838, followed closely by Schonlein, in 1839, who gave to the world "the achorion of Schonlein," the favus germ; during this time Liebig, the great chemist, was fighting against the "germ theory" as opposed to the "chemical theory." In 1841, Duardin calls attention to them, and, in 1850, Davaine made the discovery, unknowingly, of the anthrax bacillus, mentioning at the time seeing threads in the blood of patients suffering from splenic fever (pure anthrax), although so near, yet he did *not* recognize this bacillus till thirteen years later. Up to 1853 they had been considered as animalcules, when the theory was advanced as to their being vegetables, this theory being converted into a fact by Davaine; in 1859, he proved them to be vegetables. In 1862, Pasteur discovered the micrococcus urea (the cause of ammoniacal fermentation in urine), and in his experiments he found that boracic acid neutralized the effect of this germ. Dr. Guyot used this experiment, thus introducing the "era of antiseptic surgery." 1863 was memorable for Davaine's recognition of "the bacillus anthracis," and, in 1865, Lister, now Sir Joseph Lister, started in the work (the perfection of antiseptic surgery), which has made his name famous. Since then discoveries have been made right on up to the present date, a cause being found for diseases previously mysterious. A few of the most important discoveries recently are: The B. mallei by Schutz and Lœffler in 1882; the actinomyces (ray fungus), B. tuberculosis by Koch. Investigations are being made as to the presence of germs and to determine their influence, whether pathogenic or not, in tetanus, influenza, cerebro-spinal meningitis, epizootic abortion, variola, contagious pleuro-pneumonia, hog cholera, canine distemper, malignant œdema, septicemia, texas fever maladie du-coit, and others too numerous to mention. The results at present are, in the majority, not entirely satisfactory as to immediately warrant the adoption of their causation by particular germs.

By the earliest investigators, bacteria were considered as animalcules,—the reason for so doing was their property of motion; but further investigations proved their vegetable character, by optical tests with the microscope; chemical tests:—with alkaline solutions, which would dissolve them if of animal constituents, and the use of stains (methyl-violet, etc.), which immediately fixes well on most of the vegetables. They have no vital motion which includes the property of translation, or movement on its own axis. Other methods of distinguishing bacteria are by their spontaneity of motion, multiplication, more or less regularity of form, being unicellular, equality of dimensions in a given nutrition, and by various chemical tests.

Classification.—The best and most generally accepted seems to be Cohn's classification; he divides them according to morphology into four great classes.

a. *Sphero-bacteria* (micrococci), occurring as round or oval forms.

b. Micro-bacteria (bacterium), slightly elongated and oval, with rounded ends.

c. Desmo-bacteria (bacilli), cylindrical rods, rounded or square cut at their ends.

d. Spiro-bacteria (spirilli), spiral shape and motile.

They have also been classified according to spore formation into endosporous (those developing withing the germ), and arthrosporous (those that reproduce externally); but, as all bacteria do not reproduce by spore formation only, this classification is not generally used. Classification according to their oxygenation, negative or positive, and as to the effects produced by them, has also been tried. By this last they are divided into:

a. Zymogenic, or ferment forming.

b. Chromogenic, or color forming.

c. Pathogenic, or disease producing.

As we might expect, this last is the most important, and those in it occur as monads (singly), series, chains and zooglea (in which form a number of microbes are imbedded in a gelatinous or gluey mass).

REPRODUCTION AND NUTRITION.—Bacteria reproduce themselves by fission or spore formation, the latter form being the most dangerous, as they resist stains and antiseptics better through their tough envelope. Growth in all forms is dependent on certain temperature; many of them grow best at blood heat and will resist cold tolerably well; electricity and sunlight affect many of them unfavorably. Moisture seems essential to all; other necessaries are nitrogen, oxygen and carbon, these all being taken in by endosmosis. They produce their effects by either: *a.* Using up the oxygen of the blood; *b,* mechanically, *i. e.,* owing to their presence and location; *c,* by the formation of chemical poisons known as ptomaines, etc.; these are products peculiar to organisms, formed during putrefaction; some of them act as violent poisons.

MODES OF ENTRANCE INTO THE SYSTEM.—Bacteria may enter the body by the respiratory or alimentary mucous membranes, or by a wound in the skin (normal epidermis is supposed to be impervious); at present the theory held as to their introduction through the skin presupposes the existence of some abrasion or injury. In the intestinal tract they may obtain entrance by the various channels of absorption. Bacteria have been found to be present in immense numbers in the alimentary tract from their presence in the voided excrement; the various digestive juices would seem to have the power of neutralizing some of them to some extent. Experiments have been made (with, strictly speaking, negative results) to ascertain whether these organisms can obtain entrance through the skin, the B. mallei being made up into an ointment, and applied with friction. If organisms could readily enter a mucous membrane or the skin, the precautions of antiseptic surgery would be, generally speaking, useless.

Spontaneity has been dealt with by Pasteur and Tyndall, as to render it unnecessary to say much about it. Like a good many new discoveries, there seems to be a danger to run "the theories," etc., to death; to avoid this, Koch's postulates are to be adopted; they are as follows:

a. First find the micro-organism in blood, lymph or diseased tissue of the animal suffering or dead of the disease.

b. The micro-organisms, so obtained, must be isolated and cultivated outside the body and through successive generations (in number, twenty or more), thus getting a pure culture.

c. A pure culture thus obtained must, when introduced into a healthy body, produce the disease in question.

d. In the inoculated animal the same organism must be found.

These conditions fulfilled, we can say we have the history, etc., of any microbe. Often, however, we have to be content at present with the knowledge of their presence, without being able to fully determine their influence, whether pathogenic or not.

The class, *micrococci,* does not include many pathogenic organisms compared with the *bacilli.* Among them are:

a. *Streptococcus erysipelatous,* globular cells of small size, and a tendency to grow in chains.

b. *Streptococcus pyogenes albus,* said to be found in the abscess of strangles; they resemble very much the streptococcus erysipelatous.

c. Staphylococcus pyogenes, etc., found in abscesses and suppurations. In their growth, they tend to form little grape-like masses. They are present in suppurative ostitis (vide Coats' Pathology). *Micrococci* are said to exist in diphtheria, but these do not have such a great interest to the veterinarian. They have also been found in the blood and lymph glands of patients suffering from rinderpest.

Under the class *bacterium,* comes the "*bacterium termo,*" the particular germ of putrefaction. It is short and appears as dumb-bells. The organism of fowl cholera is classed here by Klein, along with the bacilli by Coats. The B. *diphtheriticus,* discovered by Lœffler, V. S., is supposed to be the cause of that dread disease, diphtheria. Doubts have arisen as to its action, it being found in some cases and not in others, and failing to produce the disease in question.

The class, *bacillus,* is prolific in pathogenic organisms, and as such excites considerable interest. Bacillus of ulcerative stomatitis in calves shows the following symptoms (vide Klein, p. 126): Ulcerations on the tongue and buccal mucous membrane; the ulcer being a sore with overhanging edges; wherever it touches it infects. The line of demarcation was found to be crowded with these bacilli.

B. mallei are very minute, about the size of the B. tuberculosis, shorter and thicker, are present in the lesions of glanders readily cultivated (?), and easily communicated to susceptible animals. It is non-motile, and is communicable to man by accidental inoculation, causing the peculiar glanderous symptoms, although these are sometimes hidden by some other affection (vide L. V. J,. Sept. 90). This bacillus has been cultivated through the various animals, such as rabbits (?), mice (?), rats and guinea-pigs, the last giving the best results, and are available as a ready means of diagnosis, especially in chronic glanders; the germ produces characteristic lesions in the ovary, vulva testes, etc., the male being the best for this purpose. The best and quickest method is the intra-peritoneal injection of the virus; the lesions will be produced in from two to four days. Coats says this bacillus loses virulence to a great extent by the fourth or fifth cultivation.

B. anthracis occurs as stiff, short and long rods; according to Davaine, is slender and square cut at the ends; it resembles the hay bacillus, and is said by Buchner to be capable of being changed into that organism, or *vice versa;* this theory is ably disproved by Klein and Koch. The bacillus (?) of symptomatic anthrax is shorter, broader and round at both ends. Klein mentions that in true anthrax, the mother does not affect the fœtus, but in symptomatic anthrax the fœtus is affected. Pasteur has experimented with the bacillus anthracis, and has shown that a permanent vaccine is obtainable. (Coats' Pathology.)

B. tuberculosis is a thin, rod-shaped cell, shorter than the diameter of a red corpuscle; it is often slightly curved or bent at an obtuse angle. The germ is the same in both man and animals, Klein to the contrary, however. This disease (tubercle) infests some of the best bred herds in the world; certain breeds being, seemingly, very susceptible to it. This bacillus is attracting a great deal of attention owing to Koch's discovery. It is said to be transmissible to man through the milk, and is thus a source of great danger. An experiment by M. Richet in conjunction with M. Hericourt for the Biological Society, Paris, in regard to preventive inoculation for tuberculosis was successful (vide *Lancet,* Nov. 29, 90).

B. of tetanus.—A germ said to be the cause of tetanus has been found in animals affected; but at present facts are not forthcoming to warrant our stating conclusively that the germ found is the specific, or only, cause of the disease.

Actinomyces (ray fungus).—This germ causes the disease in cattle known as actinomycosis; the disease is transmissible to the equine and human species; it is characterized by induration of the tongue and other lesions connected with the jaw and face. In man there is a greater tendency to suppuration than in cattle. The disease was first recognized by Bollinger. The fungus consists of short threads arranged in a radiating fashion, many springing from one center; they are united in the center by a matted mass of fibres, their arrangement thus accounting for the synonym, ray fungus. During our observations among the infectious diseases, we cannot help remarking that, no matter how seemingly virulent the disease is, some persons or animals are not attacked. This immunity, for such it is, may be "natural," *e. g.*, anthrax attacks man, sheep and cattle, but does not attack dogs or cats. This immunity may be complete or incomplete, or it may be characteristic of a species, *e. g.*, Algerian sheep are not prone to anthrax, and it has been said that strangles is unknown in the Arabian horse. When one per cent. are prone, and ninety-nine not prone, of a species to a disease, the condition is called an idiosyncrasy.

ACQUIRED IMMUNITY.—This immunity is conveyed to the individual in a variety of ways, *i. e.*: *a.* By having had the disease. *e. g.*, strangles. *b.* By acclimation, *e. g.*, malaria (this is not thorough immunity). *c.* By civilization (?). *d.* By age, *e.g.*, typhoid fever rare in old people. *e.* By protective inoculation.

Protective inoculation is of ancient origin, being practiced in India and the East long before known in England. Lady Mary Stuart Wortley Montague was the first to introduce it in Europe with the hope of mastering smallpox, which raged at the time. This noble project did not attain the object sought, as the virus being used to inoculate only spread the disease. Dr. Jenner took it in hand and perfected the scheme by his method of vaccination. He used a virus obtained from cattle, and the circumstances connected with his discovery are too well known to need recapitulation; it is sufficient to say that he has immortalized himself. This discovery is not so much in itself to us as veterinarians, as is the principle emanating from it, showing, conclusively, if we cannot render a disease (or virus) inert, we can at least prepare the animal organization to resist, with a varying degree of success, the inroads and attacks of these germs. Pasteur's work with the virus of rabies has achieved for him notoriety and a fair amount of success. Preventive inoculation for contagious pleuro-pneumonia is spoken favorably of; the law of the United Kingdom preventing any prophylactic treatment except slaughter has kept the practice of preventive inoculation back. In Australia and New Zealand it has been adopted with success; an outbreak in the last named place being stamped out by this means (vide L. V. J., May, '90).

Koch's discovery of last year drew the attention of the enlightened world, and, although it may fall short of the expectations, will no doubt encourage investigation in this direction. Pasteur located the virus of rabies in the spinal cord; by passing through monkeys, at intervals between the successive cultivations, he obtained an attenuated virus. He experimented with the bacillus of fowl cholera and anthrax, and found that in eight days, at a temperature of 45°C, virulence was lost; therefore, in less than eight days he had an attenuated virus. These experiments were subsequently verified by M. Chauveau. Having thus given our attention to inoculation, and knowing, as we do, that these specific organisms must have a suitable nidus to produce their effect, the question arises, "What gives this immunity?" Immunity seems to be afforded, *first,* by the production of some chemical substance (which may be found natural); *second,* by the destruction of the food stuff on which these organisms exist; *third,* is the result of a vital resistance.*

Having mentioned the various prophylactic treatments internal to the body, we must now turn our attention to agents which will overcome these organisms when external to the body; in a word, to antiseptics. No surgeon, or at the most, only a few surgeons in human or veterinary practice, think of going to work without these necessary adjuncts. Their internal use has not been as uniformly successful as their external use, the reason being that in order to destroy the germ, the agent to be used would have an injurious effect on the body or organization to be protected. Experiments have been made successfully, however; it being found that minute doses of mercuric chloride fortified animals so as to resist the invasion of the anthrax bacillus. Sodium sulphite had the same beneficial action when administered to dogs injected with fœtid pus. The majority of antipyretics are supposed to cause their beneficial effects by rendering inert the germ causing pyrexia. The chief antiseptics suitable for everyday use are: Carbolic acid, boracic acid and salicylic acid, iodoform, sulphurous acid solution, mercuric chloride, and creolin (Jeyes' fluid). This last-named drug is comparatively new on this side of the Atlantic, and is little known. It is derived from coal tar like carbolic acid, but it is far more potent as a germicide, antiseptic, disinfectant and deodorant, while it possesses the great advantage of being free from all toxic properties; it is anodyne instead of irritant, and it is besides a hœmostatic and styptic. It is alkaline in reaction, and when treated with acids gives an oil, which does not give the carbolic-acid reaction with ferri perchlor. A two-per-cent. solution destroys the B. mallei, and has a restraining action on the bacilli of tubercle and anthrax.

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*Attention is directed to the article of Dr. Paul Gibier in January and February numbers, explaining immunity more fully; also to the editorial in this number, concerning the discovery of protective proteids by Hankin.—P. P.]

The influence and presence of bacteria is acknowledged every day by the use of antiseptics; and if we examine the curriculum of any of the leading medical institutions of the day we find bacteria are there, either bodily or in the abstract. A knowledge of the actions and symptoms caused by these minute organisms being requisite for a correct diagnosis, which, when gained, gives us the key to treatment of a number of diseases, whether that treatment be curative or prophylactic.

HYGIENIC BACTERIOLOGY.

Report from the hygienic institute of Dr. R. Koch on the manner of producing a condition of Diphtheria immunity and Tetanus immunity in animals, by Dr. Behring, assistant at the hygienic institute at Berlin and Dr. Kitasato of Tokio, Japan.*

[TRANSLATED BY DR. A. C. BERNAYS & DR. W. A. BROOME, OF ST. LOUIS, MO.]

During our long-continued studies on diphtheria (Behring) and tetanus (Kitasato) we have also approached the therapeutic and immunity aspects of the question. In both of these infectious diseases we have succeeded in curing infected animals, and also in so treating healthy animals that they cannot afterward become diseased with diphtheria and tetanus.

The exact details of the methods of cure and immunization will not be given here; this subject will only be entered upon sufficiently to prove the following proposition:

The immunity of rabbits and mice, which have been immunized against tetanus, depends upon that property of cell-less blood-liquid (serum) to render harmless the toxic substances which are produced by tetanus bacilli.

The explanation for the immunity, which has been expressed in the preceding sentence, has never been previously touched upon in any of the papers or works on the immunity question published up to the present time.

Besides the doctrine of phagocytosis, which seeks to find an explanation of immunity in the cells, the bactericide or anti-bacterial properties of the blood, and the power of the organism to become accustomed to poisons, were brought forward as explanatory elements.

Whenever one of these three explanatory dogmas was proven insufficient, or was recognized as false by experimenters, the others were left to fall back upon *per exclusionem.* Bouchard, before the Tenth International Congress, in a most significant speech on the immunity question, defining the question, said: "Ne parlons donc plus d' entrainement des leucocytes et d' accoutumance des cellules nerveuses aux poisons bacterieux; c'est pure rhetorique," and, "C'est en effet cet etat bactericide qui constitue la vaccination on l' immunite acquise."

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* Detailed accounts will appear in the Zeitschrift fur Hygiene.

This positive statement amounts practically to the same as was said by Roger * in the following words : "La vaccination determine dans l'organisme des modifications chimiques qui rendent les humeurs et les tissues peu favorables a la vegetation ou microbe contre lequel on a premuni l' animal."

Now comes one of us (Behring) and finds by his studies on diphtheria-proof rats and immunized guinea-pigs, that none of the above-mentioned theories can satisfactorily or in any way at all explain the immunity of these animals, and he was compelled to search for another element of explanation. After many vain efforts, the right direction was recognized when the poison-destroying effect of the blood taken from diphtheria-proof (dipththeria-immune) animals was found, and it was seen that the resistance and unreceptivity for diphtheria depended upon it. After the application of our experiences with diphtheria to tetanus, we arrived at results which, so far as we are able to recognize, leave nothing to be wished for in the chain of evidence.

The experiments prove the following propositions :

First. The blood of rabbits that have been immunized against tetanus possesses properties which destroy the tetanus poison.

Second. These properties have also been shown in extravascular blood, and in the serum of such blood.

Third. These properties are of such enduring nature that they remain effective in the organism of other animals, so that we are able to achieve eminent therapeutic action by the transfusion of this blood or serum.

Fourth. The tetanus-poison-destroying properties are absent in the blood of animals that are not immunized against tetanus, and, if the tetanus poison is injected into animals not immunized, the same may be shown to exist in the blood and other fluids after the death of the animal.

We will now give the experiments which prove these propositions :

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* Contribution a l'etude de l' immunité acquise, 1890.

A rabbit was immunized against tetanus after a method to be described hereafter by Kitasato in detail. After testing the degree of immunity in this animal the same was given 10ccm. of a virulent pure culture of tetanus-bacilli. 0.5ccm. of this fluid sufficed to produce lockjaw in a normal rabbit and kill with absolute certainty. The first-mentioned rabbit remained healthy.

The same had not only secured immunity against the infection with living tetanus bacilli, but also against the tetanus poison; for it bore twenty times the amount of the poison without injury, which sufficed to kill normal rabbits in every instance.

Some blood was taken out of the carotid of the immunized rabbit. Of this liquid blood before its coagulation 0.2ccm. were injected into the abdominal cavity of a mouse, and 0.5ccm. were injected into another mouse.

Both mice, together with two others, were inoculated with virulent tetanus bacilli after twenty-fours ; the inoculation was made so strong that the two control-mice were taken with tetanus after twenty hours, and died after thirty-six.

Both mice which had been injected with the blood of the immunized mouse remained permanently well.

The greater amount of the blood was left standing until the serum had separated from the clot. Of this serum, six mice each received 0. 2ccm. into the abdominal cavity; twenty-four hours afterward they were infected, but all six mice remained permanently well, while six control-mice died of tetanus after less than forty-eight hours. With this serum therapeutic successes have been achieved by first infecting normal animals and afterward injecting the serum into the abdominal cavity.

Furthermore, we have made experiments with the serum which established the enormous poison-destroying effect of the same.

A tetanus culture ten days old was prepared, which was freed of germs by filtering. Of this, 0.00005ccm. sufficed to kill a mouse in from four to six days, and 0.0001 ccm. sufficed to kill a mouse in less than two days with absolute certainty. Now we mixed 5ccm. serum of the tetanus proof-rabbit with 1ccm. of the culture and allowed the serum to act upon the tetanus poison contained in the culture for twenty-four hours. Of this mixture, four mice received 0.2ccm. (equal to 0. 033ccm. culture) an amount equal to more than three hundred times the quantity ordinarily a fatal dose for mice; the four mice remained permanently well. The control mice died thirty-six hours after a dose of 0.0001ccm. of the culture. The mice of all the experiments above-mentioned—those which received the serum in the abdominal cavity as well as those which received the mixture—have become permanently immunized ; they have withstood repeated inoculations with virulent tetanus bacilli without showing the slightest trace of disease. This fact is of particular importance, because in innumerable exeriments no mouse, no rabbit, in fact no animal ever tested, was found naturally immunized to tetanus, and also because no other method attempting to immunize any species of animals against tetanus has ever succeeded.

We may, therefore, draw the conclusion that the conception expressed in the beginning of this article about the manner in which the immunity is brought about answers a far-reaching demand for a causal explanation.

THE PRODUCTION OF IMMUNITY WITH THE CHEMICAL SUBSTANCES FORMED DURING THE GROWTH OF THE BACILLUS OF HOG CHOLERA.

BY E. A. V. SCHWEINITZ, PH. D.

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(Continued from February Number.)

EXPERIMENTS 5.—Six guinea-pigs were inoculated for this experiment, two with solution of the sucholotoxin and four with a solution of the mixed sucholotoxins. The sucholotoxin solution produced only slight local lesions, while the mixed toxins caused ulceration at the point of injection which did not heal for two weeks. The treatment in this case again extended over a period of from three to four weeks. The animals having by this time recovered, the test experiment with hog-cholera virus was tried

Four of the animals mentioned above were taken—two from each set—and also two checks, and the six were inoculated. The checks died in eight and nine days, the autopsies showing the characteristic conditions of death from hog cholera. Those that had the preventive treatment were ill and dull for from four to six days after the inoculation. At the point of inoculation there was also some swelling and infiltration, very slight, however, compared with the similar swelling on the checks. In the treated animals the swelling sloughed and healed, and within ten days after the inoculation they were perfectly well. To test the resistance of the animals, that had been treated by this method, to ordinary exposure the following experiments were conducted.

Experiments 6.—Two guinea-pigs that had received the preventive treatment, two blanks, *i. e.*, animals that had received no treatment, and two check animals that were inoculated with hog-cholera virus were placed in one large cage. The checks became ill and died in eight or nine days from hog cholera. During this time the cage was cleaned only three times, so as to give full and free opportunity for contagion. One week after the checks had died one of the blanks became ill, and died within ten days. The autopsy showed hog cholera lesions. The second blank became ill a few days after the first blank succumbed, and died within thirty days. The animals which had the preventive treatment are now and have been quite well, though continually exposed for five weeks to every opportunity for contagion.

Experiments 7.—These experiments are a step in advance of those already recorded, and, although not quite so conclusive, indicate that the proper methods have been adopted.

A pure chemical compound, prepared synthetically in the laboratory, was used for treating the guinea-pigs. Three animals were taken, and this compound was administered to them by the method already used. There was a slight rise in temperature of the animals and swelling and soreness at the point of injection. After this had healed these animals and two checks were inoculated with 0.1cc. of hog-cholera culture. The checks died in eight and nine days. The animals which had been previously treated became ill, two dying five and six days after the checks. The third entirely recovered.

Post-mortem examination of the two that died showed the following: At the point of inoculation the skin had sloughed away over an area of 1 sq. cm. The superficial muscular layer was necrosed over an area of about 3 sq. cm. and to a depth of 1 mm., lymphatics in the fold of the knee much enlarged; Peyer's patches enlarged and pigmented; spleen *very slightly enlarged and not discolored;* kidneys reddened; lungs normal. Cover-glass preparation from the spleen showed a few hog-cholera germs. On both sides of the spinal column were several grayish tubercles, from 1-4 to 2 mm. in diameter, lying just beneath the peritoneum. This material is being more fully tested, and experiments which promise to be successful are also being made upon hogs. Autopsies made from the animals of Experiments 7, three or four weeks after their recovery, showed that the parts were perfectly normal, not even a scar being left upon the skin, and the immunity produced was therefore *perfect.*

It is important to add that in all the experiments great care was taken that the solutions used were free from germs, cultures always being made. In cases in which the albumen is used this is particularly important. A single precipitation with absolute alcohol does not suffice to destroy the germs, and it is necessary to free the solution from germs by means of a Pasteur filter, or in some other suitable way. Therefore, experiments made with material which has not been tested for germs are practically of no value. As to the poisonous character of the ptomaines, a single large dose is sufficient to kill a guinea-pig in from one hour to two days. The autopsy of a case of this kind is as follows: Liver, pale and fatty; subcutaneous tissue over abdomen, necrosed and infiltrated; muscle, soft and friable; other organs, apparently normal.

The experiments here recorded show:

First. That in guinea-pigs *complete immunity* from hog-cholera can be produced by *chemical inoculation.*

Second. The sucholotoxins and sucholo-albumen are equally effective in this respect, and a mixture of these two products gives greater immunity than either used by itself.

The effect of the albumen in producing immunity from anthrax has already been pointed out by Hankin, his experiments being very successful.

Third. The sucholotoxins given in large doses produce death. To produce immunity they should be administered in small quantities at a time and at frequent intervals, the system being in this way accustomed to the poison and enabled to resist it.

Further study in this interesting line of work is in progress.

The tabulated results of the foregoing experiments are appended :

TABULATED RESULTS OF EXPERIMENTS IN PRODUCING IMMUNITY FROM HOG CHOLERA IN GUINEA-PIGS.

Number of experiment.	Material used for treatment.	Hog-cholera virus used for each animal.	Number of animals. used.	Number of checks.	Number of days between inoculation with virus and death of checks.	Result in treated animals.
I.	Sucholotoxin	0.10 cc.	2	2	8 and 9	1 died in 11 days ; 1 recovered.
II.	Sucholo-albumin..........	do.	2	2	7	Died in 17 days ; great resistance.
III.	Sucholo-albumin...........	do.	3	2	8 and 10	Recovered ; immunity.
IV.	1. Sucholotoxins	do.	2			Recovered ; immunity.
	2. Sucholotoxin and albumin..	do.	2	2	8 and 10	
V.	1. Sucholotoxin................	do.	2			
	2. Sucholotoxins..............	do.	2	2	8 and 9	Recovered ; immunity.
VI.	Sucholotoxins.............	do.	2	2 blanks		Blanks died in 18 and 30 days.
				2 checks	8 and 9	Others not affected ; immunity.
VII.	Pure chemical	do.	3	2	8 and 9	Two died in 13 and 14 days. Third recovered ; immunity.

From reprint of Medical News.

SURGICAL BACTERIOLOGY.

ANTISEPTIC SPONGES.

PROF. J. PERRINS (in *Gaz. de Gynec*).

Take a string of fine, new sponges, neither too large nor too small. Commence by beating them with a small hammer, or a piece of wood, in order to knock out the dust and any mineral particles that they may contain. Examine particularly the point where the sponge was attached to the rock; often there are minute grains of sand firmly adherent at this point, and which should be absolutely removed to avoid irritating an already painful wound. It is better to cut this point off with the scissors. Having done this, wash the sponges freely in water, squeeze, and place them in fountain basins, preferably enameled ones, containing the following solutions:

Hydrochloric acid	10 grams.
Water	1 litre.

Allow them to remain six hours in this mixture, then wash freely again in water, and steep them for six hours in the following:

Water	1 litre.
Permanganate of potash	1 gram.

By treatment of a chameleon solution of a beautiful, intense violet hue, they will become more or less rapidly discolored, and, after washing freely in water, will retain a brownish shade.

Immerse the sponges next in the following liquid for two hours:

Liquid bisulphite of soda	10 grams.
Water	1 litre.
Hydrochloric acid	1 gram.

A slight odor of sulphurous acid gas will be perceived. After a little while the sponges lose their brown color, and assume a beautiful, whitish yellow shade.

Wash again freely in water and introduce them into a preserving fluid made as follows, where they should be kept until needed:

Water	1 litre.
Carbolic acid	1 gram.
Alcohol	5 grams.

Dissolve the carbolic acid in the alcohol and mix together in the aqueous solution.

In order to remove the odor of the carbolic acid, which the laity always associates with hospitals, we may use in the place of the above solution the following preserving fluid :

Thymol	1 gram.
Alchohol	4 grams.
Water	1 litre.

—*Reg. Pharmacist.*

SELECTIONS.

THE TREATMENT OF TUBERCULAR JOINT-DISEASES BY MEANS OF IODOFORM INJECTIONS,

By Prof. Tedor Krause, Halle.
[From the Archiv. fur Klinische Chirurgie, Vol. 41,]

[TRANSLATED FROM THE GERMAN BY H.W. LOEB, A. M.,M. D., ST. LOUIS, MO.]

In my communication, in the *Berliner Klinische Wochenschrift*, 1889, No. 49, upon the above subject, I mentioned that, in my researches toward the cure of tuberculosis of joints by intra-articular injections of iodoform, I had chosen at first only the severe cases for the most part with abscess formation, those which our experience had shown could not be cured without serious operative interference. When the result of the severe forms of the disease became encouraging, I further experimented with the milder cases and in the very beginning of the disease. In these we can with fair reason hope for a cure before the pus forms in the joint. I have treated the following joints, during two years, with intra-articular injections:

Kneejoint	36 times
Hipjoint	13 times
Tarsaljoint	6 times
Wristjoint	5 times
Elbowjoint	1 time

The treatment is not yet completed in a portion of these cases, or has not been carried on sufficiently long to offer a definite conclusion. As far as I could determine in regard to the cases treated before, a cure resulted in the

Kneejoint	15 times
Hipjoint	4 times
Tarsaljoint	1 time
Wristjoint	3 times

An improvement occurred in the great majority of those treated. These are the successes; now I shall not pass by the failures. In a case of kneejoint disease, arthrectomy was necessitated on account of advancing tuberculosis—and in a case of tuberculosis of the tarsaljoint, in a woman, aged 45, an amputation of the lower part of the thigh was later performed. A man, aged 19, with tuberculosis of the posterior portion of the anklejoint, was taken sick with meningitis four weeks after the washing out of the abscess and the injection of the iodoform mixture, and died ten days later from tubercular meningitis and pulmonary tuberculosis. Whether or not the surgical interference was the immediate occasion for the outbreak of the tubercular meningitis, I do not venture to decide. The period of four weeks between the injection and the inception of his fatal sickness seems somewhat long. It is well known, especially since Kœnig has made observations upon this subject, that as an immediate result of operative interference, especially in the train of smaller operations, as scraping and the like, such as was done in the tubercular joints, acute miliary tuberculosis occasionally takes place. According to our experience, the first symptoms of the general injection occurs within ten or fourteen days, and not as in the above-mentioned cases after four weeks.

A further case is that of a patient, aged 37 years, with severe kneejoint and pulmonary tuberculosis, who while the kneejoint disease was perceptibly benefited by four injections, succumbed to advancing phthisis pulmonalis.

I obtained the best results in knee and wristjoints, Especially were the results thorough in the severe cases of tuberculous suppuration of the wristjoint occurring in older people, which otherwise would have necessitated amputation of the forearm, or at least resection of the wristjoint, and they were sometimes surprising, even when the patient had phthisis pulmonalis. So, also were two cases of the severest form of tuberculosis of the hand accompanied by suppuration, one of which was complicated by fistulæ; both who had been sent to the clinic for amputation were perfectly cured, and in both patients the movement of the finger is painless, although, of course, active motion of the wristjoint is impossible. Just so severe is a third case, a woman, who is now after three injections, on a road to certain recovery.

Among the kneejoint patients, in a single very severe case a cure with free motion resulted. I may here exhibit some of these patients, so treated. This boy, Reinhold R., had formerly, upon the head of the right tibia, a caseous sequestrum with the formation of a tubercular abscess. The sequestrum had been removed. At that time there was no disease of the kneejoint apparent. Some months later the patient returned for treatment, with severe tuberculosis of the right kneejoint. There were great swelling of the capsule and a large purulent effusion with stretching of the ligaments so that side motion was warely possible. Five injections of ten to twenty grams (ʒijss to ʒv) were given within a period of four months. Since then a year has intervened, and, you see, the healing of the condition has continued. The patient can bend his knee to the right, and is not hindered in the use of the leg.

This boy, Walter F., three years of age, had no effusion but presented severe swelling of the capsule, and a slight subluxation backward, so that he had to submit to a triple extension. As the internal condyle of the tibia was greatly swollen and pressure was very painful, a deposit here could well be conjectured. A cure followed four injections, and it has remained well for a year. The boy can bend his knee to the right, but cannot fully extend it; but in this the use of the leg is not prevented.

Finally, I present to you an eight-year-old boy, Max V., who suffered from a tuberculosis, of moderate severity, in the left kneejoint. A gelatinous, purulent discharge with cheesy shreds of tissue was constantly flowing from the opening. By three injections a cure with complete normal mobility of the joint resulted which still persists (a year later).

But not simply in childhood should the results be thoroughly exhibited, but also in the adult.

So I present a woman, aged 40, who suffered from a left-sided gonitis (inflammation of the knee) with trifling purulent discharge and severe swelling of the capsule. By passive motion which gave the patient intense pain, crepitation could be felt. In four weeks after the first injection the patient was entirely free from pain, and on standing could somewhat bend the knee. Three other injections caused a cure so that the patient can now bend her knee to the right, and for five months can go around without any sensation of pain. Slight crepitation can always still be obtained, though it is entirely painless.

This man, aged 20 years, furnishes the best example of the value of the method. This was one of those cases of considerable and very soft fluctuating swelling of the capsule, which offer such a bad prognosis as to a cure. The young man had previously been treated with plaster-of-Paris dressing and with irrigation of a sublimate solution, but the swelling of the capsule increased, and the pain became intolerable. For a long time he was unable to stand or to walk. Each movement of the leg being extremely painful; yes, the slightest shaking of the bed occasioned simply by approaching it caused the patient exquisite pain. Without morphine, he could not exist. Regarding this case I consulted fully with Von Volkmann who gave not much hope for a lasting cure even by an arthrectomy. He advised me in any case to prepare myself to make an amputation of the thigh which later would be necessary. He was treated with iodoform injections as a last resort. Its action in this case was astounding—I cannot call it anything else. The pains were really slight, only fourteen days after the first injection; fourteen days later they had entirely disappeared; after the second injection, and four weeks of treatment, the patient could go around without supporting apparatus. In all four injections of 20 to 40 grams (ʒv–x.) were necessary within the four months. The cure was followed by kneejoint anchylosis, and now a year after remains the same.

In all the cases of hipjoint disease, in which on account of its duration a final sentence was passed, I, nevertheless, obtained anchylosis. This concerns the cases with abscess formation, to which I applied the injection. Still, here I may show two, who recovered from coxitis of the severest form, with numerous abscesses, loss of cartilage and even having had the luxation-posture. We obtained a recovery with more or less well-maintained motion, where we applied the iodoform injections in the beginning of the malady. This point experience must decide. The cases which I have heretofore treated have not been observed sufficiently long to warrant a definite conclusion, especially two cases of coxitis with abscesses, which at first showed free movement but later resulted in complete anchylosis. Although anchylosis intervenes in the treatment of the hip-joint there should, however, be no ground to cast aside the method for this joint.

It was the opinion of Volkmann (and I properly verified this opinion at the previous congress) that after a partial resection of the hipjoint a firm, bony anchylosis between the acetabulum and the resected femur with moderate abduction of the leg was the best thing for the poorer classes of society, who cannot bestow so much attention to the after treatment. Such an anchylosis alone will guard against frequent severe returns of adduction and flexion. The same opinion naturally holds for the cure of coxitis without resection.

The treatment with iodoform injections is, therefore, easily carried out while the patient, who is, of course, watched with the ordinary orthopedic measures, needs remain under observation only a few days after the slight attack.

We have frequently observed, where patients or their relatives had been properly instructed, a subsequent injection taken *ambulant*. Now, in whatever the method of iodoform injections is concerned, there is a certain difference, whether we dealt with internal abscess formation in the vicinity of the joint or simply with fungous increase of the synovial membrane. We evacuated all the tuberculous abscesses, as well as the joint abscesses, generally with a strong abdominal trochar in order to be able to remove the thick clots of cheesy tissue and the loosened pieces of the abscess membrane, sometimes contained in the pus. Through the canula we irrigated the abscess cavity with a three-per-cent. solution of boric acid until all the shreds of tissue were washed out and the water passed out clear; then we injected through the opening a ten-per-cent. solution of iodoform (in pure glycerine or in water with some glycerine and mucilage of acacia) into the abscess and the joint, sufficient to fill it slightly.

The average quantity necessary amounts to 15 to 40 grams (about ℥ss–℥jss); I have occasionally gone higher,—in one case using 80 grams (℥ijss). I have never found it necessary to suture the opening produced by the large trochar; it suffices if, after the withdrawal of the canula, the skin is drawn together into a fold, the little wound closed with a pad of gauze, and a slight compressing bandage placed thereon.

When there appears in the abscess thick shreds of tissue, which continually stop up the canula, as does occur in the large burrowing abscesses, descending from the vertebral column, the puncture should be enlarged to a sufficient length by introducing the knife upon the canula. This wound must, of course, be sewed before the use of the iodoform injection.

For the treatment of tubercular joint diseases without discharge and suppuration, I used for puncture and injection a trochar which needs only to be 2 mm. ($\frac{1}{12}$ in.) in diameter. It is much easier to penetrate the joint cavity with this than with the Pravaz needle. The quantity of the drug to be injected in such cases naturally corresponds to the smallness of the cavity; children often bear only 5 grams (ʒ j$\frac{1}{4}$).

In every case—with or without suppuration—while the opening is closed, one should, as much as possible, make passive motion in the operated joint, in a distributive way and in all directions; by this means the entire joint region will be thoroughly massaged. In this way, I endeavor to obtain an equal distribution of the iodoform in all the folds and angles of the abscess and joint cavities; perhaps on account of this, it happens that the iodoform is rubbed into the fungous masses, which are often so soft.

The most convenient and proper place in which the individual joint should be opened by a trochar, I have determined by experimentation upon the dead body. The wristjoint is accessible on both sides, close under the styloid process of the radius and ulna; the elbowjoint is reached by pressing deeply over the head of the radius, so easily perceptible in pronation and supination. The shoulderjoint, of which I have not had any disease to treat in this way, should be entered in a place external to the coracoid or external to the spine of the scapula in its passage to the acromion, where the swelling of the capsule of the joint and the abscess can be distinctly felt. The best for the injection into the hipjoint is to enter upon the greater trochanter with a trochar 7 to 9 cm. (2¾ to 3½ in.) long. In accordance with my autopsies, the following procedure is the most positive. While the patient is lying flat upon his back, the trochar is plunged perpendicular to the axis of the thigh immediately above the top of the trochanter major, midway between the anterior and the posterior edges, rather further in front, and is pushed slowly forwards until the sensation of bone is perceived. On this account the leg must in no case be adducted and ever so little rotated outwardly, because the trochar might easily strike the margin of the acetabulum. Flexion, also, must of necessity be avoided with care. The best position for the thigh is adduction and slight internal rotation. If bone is felt with the trochar, it is the head of the femur, or the neck of the femur, near it. Thereupon the leg should be adducted as strongly as possible, and the trochar slipped in, somewhat above and more deeply, retaining throughout the bone sensation (the head of the femur) until bony resistance again interferes. Then it will be in the joint cleft between the femoral head and the margin of the acetabulum, and the stylet can be withdrawn, after which the canula may be shoved somewhat deeply into the joint cavity, and the injection given. A trocar 7 to 7.5 centimetres (2¾ to 3 in.) long is the proper length for a fleshy adult ; in children, correspondingly less.

This treatment permitted without difficulty the injection of 40 grams (ʒx) of the fluid into the hipjoint of a child, five years old, in which discharge was not apparent. Observation upon the dead body has certainly convinced me that in the living body the capsule of the hipjoint may be penetrated in the way described. In a case in which at first an abscess disappeared after the injection with iodoform, the fluid passed from the hipjoint into the old abscess cavity, an indication that a communication must still have existed between the hipjoint and the old abscess. In two other cases the iodoform injection into the hipjoint made its appearance at fistulous openings, far from the joint, and on the anterior portion of the thigh. In a boy aged 13, the hipjoint was evacuated by a second puncture, and, while at first a discharge did not appear, about a teaspoonful of thick, stringy synovia came out of the canula, and in this case 60 grams (ℨ xv) was easily injected into the joint.

The kneejoint is punctured in the usual way, viz., under the patella. In the anklejoint it is best to puncture perpendicularly under the apex of one of the malleoli, and then to move the trochar upwards. For the other joints no special directions are necessary.

It has often happened to us, especially in dealing with the knee and the hipjoint, that, though the first injections were very mild, the later ones were given with difficulty and with much resistance. The reason is clear; after the iodoform injections a change occurs in the diseased capsule which produces a cicatricial contraction and thereby a cure, at the same time, however, greatly diminishing the size of the joint capsule.

It was very remarkable, in some cases, how very rapidly the general condition improved in the course of the treatment. We have very often observed this. A wonderful example is a case of kneejoint tuberculosis which I present to you in the person of this young man. His general condition had suffered uncommonly on account of the severity of his disease, and especially because of his sleepless nights; just as soon, however, as the kneejoint disease improved, he developed strength, and now he enjoys blooming health.

With respect to the remaining points, I must direct you to a communication which has already appeared in the *Berliner Klinische Wochenschrift* and to my forthcoming (in a few weeks) monograph upon "Tuberculosis of the bone and joints."

THE FILTRATION OF WATER.

BY W. E. DUCLAUX.

(Translation from the French continued from February number.)

All these bodies may, on the other hand, be affected by another means. They are more easily decomposable than the veritable albumenoid matters, under the action of the alkalies, which transform them into ammoniacal salts,as they do ordinarily all the amides. So that if we boil them with potash, and if we had in preference to this potash an oxidizing body as the hypermanganate is, which adds its destructive action on the organic matter, we will succeed in transforming into ammonia the total or nearly the total of the nitrogen of the amides, whilst on the contrary the complex albumenoid matters would be more resistent.

This ammonia resulting chiefly from the transformation of the amides should be, in its turn, distinguished from ammonia which may exist already formed in water. All waters contain a little, and, when there is a little, the significance of the presence of this body is hardly clear. Some of it is produced by the action of microbes on nitrogenized matters, and consequently its presence may be evidence of the existence in water of the products of fermentation of animal matters, perhaps also of the products of the decomposition of urea, which a diastase transforms easily into carbonate of ammonia. But, on the other hand, this ammonia is formed principally, as I have shown, during the life of aerobic microbes, which of all germs are evidently the least dreadful, and as there are microbes everywhere, and we cannot avoid them, it is better to have to deal with the most harmless. Finally, this ammonia of water may serve in its turn for other microbes, and by their assistance reach the rank of albumenoid matter.

All these opposite actions render very uncertain the diagnostic value and the significance of the presence of ammonia in water. Still we should consider it as decidedly unfavorable when its proportion reaches or exceeds one or two milligrams per litre, and it is better that water contain none.

This ammonia can be measured with great precision in distilling a half litre of water with a few drops of a potash solution, and in treating by means of ten-per-cent. solution of sulphuric acid or oxalic acid the first portions of the liquid distilled. When this operation is ended, and before the remainder of the liquid is cooled, we add to it 20cc. of a solution containing 8gr. of hypermanganate of potash and 200gr. of caustic potash per litre. We begin to distil over again ; we take 50cc. two or three times, and of each of them we measure the ammonia. When the last contains no more, we stop, we add the total, and we have the ammonia coming chiefly from the hydration of the amides. It is this ammonia that we record under the singular term of albumenoid ammonia. It is certainly the albumenoid matters which furnish the least of it, and it is chiefly an evidence of the presence in water of the products of the most advanced destruction of these albumenoids ; it is even this that gives it its principal interest.

We may now form an idea of the transformation brought about in the water which filters, by the action of the microbes which it meets, especially in the upper layers of the sand. We may consult the excellent publications of the commission that the waters of the city of Zurich, where the oxidability, albumenoid ammonia, the free ammonia and the number of bacteria per litre are simultaneously determined. Here is in milligrams the average figures for 1888. We have replaced the figures relative to the oxidability by the number of the milligrams of oxygen yielded by the hypermanganate and the organic matter of one litre of water.

	Consumed oxygen.	Albumenoid ammonia.	Free Ammonia.	Bacteria.
Before filtration	3.76	0.039	0.009	188,100
After filtration............	3.04	0.023	0.003	1,190,000

Consulting these figures, which resemble those of preceding years, we see that the water loses in passing through the filter the greatest portion of its free ammonia, a portion of its organic matter, and as much as we can judge by these fatally incorrect figures, the more notable fraction of its nitrogenized elements which are close to the group of amides. Conclusions are the same concerning the waters of Berlin.

Where is the principal seat of this destruction of organic matter ? An interesting experiment of Mr. Piefke shows that it is principally in the superior layers, the richest in microbes. Through three filters of the same sand, and the thickness of which, from 0m7, 1m4 and 2m1, were to one another as the numbers 1, 2 and 3, it filtered the same water with the same speed, analyzed at its entrance, and at the exit from a point of view of oxidability and concerning the quantity of free oxygen contained. Here are the relative figures on the thirteenth of January, 1889. I give, as comparison, the result of the industrial filtration of this water from a microbe point of view, the same day. The oxidability is estimated as above in milligrams of oxygen, the free oxygen in cubic centimetres per litre :

	BEFORE FILTRATION.		AFTER FILTRATION.	
		Filter of 0m7.	Filter of 1m4.	Filter of 2m1.
Oxidability	6.6	5.1	4.7	4.6
Free oxygen ...	7.9	4.8	3.1	4.6
Bacteria	62,840,000		3.700,000	

If we would have an idea of what transpires in the first third and in the two first thirds of the thickest filter, we have evidently only to subtract one from the other the figures relative to the oxidability and the free oxygen borrowed from the three filters which have served for the experiment. We have then, in decomposing in our mind the filter of 2m1 into three superposed filters of 0m7 of thickness, 1mg5 for the variation of the oxidability of the superior filter, 0mg4 for the middle filter, 0mg1 for the inferior filter. The effect produced decreases then in the same way that the number of bacteria does from the top to the bottom of the filter. Undoubtedly, this coincidence does not suffice to establish their relation from cause to effect; we might say again that, if combustion is not carried on equally through the layers of the filter, it is because the oxygen is scarcer and scarcer as we descend, as is proven by the very figures of the preceding table. We may answer that after the passage through the filter of 1m4, there remained still 3cc. of free oxygen from 8 which existed at the beginning. Besides in a sterilized filter in which the water arrives drop by drop so that it remains penetrated by oxygen, there is no perceptible combustion. We must, therefore, forsake the idea of seeing in this combustion a phenomenon of ordinary chemical oxidation. The same experiments cited above with the sterilized filter precludes the attribution of the diminution of the organic matter to a wall action in passing through the filter. There is nothing left, then, in it, than the result of the vital action met in all the thickness of the filter but chiefly in the superior layers.

If it is thus, we get a reply to the question that we had asked ourselves above, without being able to solve it; it is evidently necessary that water remain a certain time in the filter to allow the microbes to exert their influence. We can ascertain this duration of contact either in diminishing the pressure on the water, or in augmenting the thickness of the filter for the same pressure. The first method is evidently the most economical, and experience has taught in each case what combination between the filter and the pressure was the best, to bring about the most notable increase in the number of bacteria and in the quantity of organic matter in water after filtration. As we may foresee, this combination varies with the degree of the impurity of the water. Thus at Berlin, at the factory of Stralauer Thor, where water of the Spree is used, which is in general impure enough, a rapidity of 1m18 per day is scarcely exceeded. This rapidity may reach three metres in the establishment where water of Tegel lake is filtered which is generally much less laden with germs and organic matters. Finally we have seen that at Zurich, where the waters of the lake are still purer, twenty-eight metres per day could be passed through the filter without compromising its working perceptibly.

We see clearly now what is a sand filter. The sand serves both as a break to moderate the movement of the water, and as support, for the slimy coating of microbes which forms itself in all its thickness, but principally on the surface. This superficial coating becomes, when it is formed, the true filtering layer, and after having operated mediumly until then the filter is at last ripe and complete; but this filtering coating is a fragile thing. We must not submit it to too strong pressure when it is weak;

its elements would break loose, would be carried away in depth of a filter and obstruct it. We must not either submit it to rapid variation of pressure which would produce the same effects. We must let it work slowly, increase the pressure gradually in proportion to the increased thickness of the coating, and according to its increasing resistance and impermeability; then, at a given moment, when the pressure used has become too great stop the water, let the filter exhaust itself, remove the superior filthy coating and put the filter in operation again. The space of time between two cleanings is called a *period.* It is evidently the shorter—everything being otherwise equal, that the water to be filtered is dirtier and more impure. It is thus that at Berlin, at Stralauer Thor, the average duration of the period in 1888 has been sixteen days with an average speed of 1m1 per day, whilst the Zurich, has been in 1887, for a covered filter forty days, with an average speed of 4m5 per day.—*Annales de L'Institut Pasteur.*

[*To be continued.*]

EHRLICH'S TEST IN TYPHOID FEVER.

BY CHARLES E. SIMON, M. D., *Assistant Physician, Johns Hopkins Hospital.*

A Paper read before the Johns Hopkins Hospital Medical Society, October 20, 1890.

It had long been known that when amido derivatives of the hydrocarbons of the benzine series are treated with nitrous acid, compounds are obtained which, owing to their extreme instability, and the readiness with which they enter into combination with an almost infinite number of other bodies, especially with aromatic compounds, have become of great practical as well as theoretical importance.

Particularly interesting is the fact that a very large number of our dyes are derived from these bodies. They were discovered by Peter Griess, and termed by him diazo-compounds.

With the expectation of demonstrating by a color reaction some of the aromatic bodies, the existence of which in the urine had been rendered highly probable by the researches of

Baumann and Brieger especially (*Zeitschrift f. Physiol. Chemie*, Bd. 3), Ehrlich undertook a series of carefully conducted experiments in this direction.

A preliminary account of these investigations he published in the *Zeitschrift f. Klin. Med.*, Bd. 5, in 1882, which was followed by a more complete account of his results in the *Charite Annalen*, 8ter Jahrgang, in 1883.

The practical value of these, especially as regards their diagnostic importance in typhoid fever, has been the subject of much controversy, and it appears at the present day that the so-called Ehrlich's reaction is regarded by many as a medical curiosity of absolutely no diagnostic importance whatsoever; Petri and Penzoldt are the exponents of this side (Penzoldt, *Berl. Klin. Wochenschrift*, 1883 and Petri, *Zeitschrift fur Klin. Med.*, 1884). The manner, however, in which these two observers entirely disregard the instructions given by Ehrlich, in order to insure success in the simple experiment, deprives their work of all value; for, as Ehrlich says, "there are but few tests in chemistry which cannot be spoiled by careless manipulation." (Ehrlich, *Deutsche Med. Wochenschrift*, 1883.)

A great deal of confusion has also undoubtedly arisen from the fact that the exact color, produced in the experiment, has either been described improperly, or simply spoken of as the "characteristic reaction," a term conveying no idea whatsoever. As the original work done by Ehrlich does not seem to be fully appreciated, it is my purpose here to describe the methods of testing which I have found most useful, and show that my results, on the whole, coincide with those which he obtained.

Since the preparation of chemically pure, crystalline diazo-compounds is quite a difficult process, Ehrlich made use of the fact that sulphanilic acid, when treated with nitrous acid in a nascent state, forms in solution the diazo-benzine-sulphonic acid, which thus becomes the active principle in the mixture employed.

The sulphanilic acid, used for this purpose, is the para-amido-benzine-sulphonic acid, prepared on a large scale, and used extensively in the coal-tar color industry.

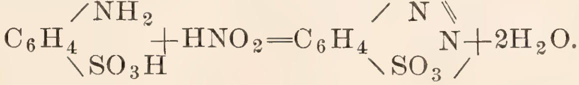
Other compounds, of course, can also be used, as the meta-amido-benzine-sulphonic acid, the ortho and paratoluidine-sulphonic acids, and others, but among all these Ehrlich has found the common sulphanilic acid the most convenient.

Two solutions are employed and kept in separate bottles, the one containing 50 cc. of hydrochloric acid, which is diluted to 1,000 cc. and saturated with sulphanilic acid, the other being a ½ per cent. solution of sodium nitrite.

To make the test, 40 cc. of the sulphanilic acid solution are taken in a measuring glass, and 1 cc. of the sodium nitrite solution added, the mixture being thoroughly agitated. The hydrochloric acid now acts upon the sodium nitrite, forming nitrous acid which, in a nascent state, forms the diazo-benzine-sulphonic acid by its action upon the sulphanilic acid. Small quantities of the sodium nitrite are used, and the absence of any free nitrous acid in the mixture is thus insured, and at the same time very small quantities of the diazo-benzine-sulphonic acid are formed—one of the principal requirements to insure success in the experiment.

The reaction which thus takes place is represented as follows :

I. $NaNO_2 + HCl = Na\,Cl + HNO_2$

II.


$$C_6H_4\begin{matrix}\diagup NH_2\\ \diagdown SO_3H\end{matrix} + HNO_2 = C_6H_4\begin{matrix}\diagup N \diagdown\\ \diagdown SO_3 \diagup\end{matrix}N + 2H_2O.$$

Para-amido-benzine-sulphonic acid. Diazo-benzine-sulphonic acid.

In his original article, Ehrlich advised the addition of this mixture to the urine, to be tested, in the proportion of 1 : 1 per volume. If ammonia is added in excess to the urine thus treated, the color play, presently to be described, occurs. In a later communication (*Charite Annalen*, Bd. 11, 1886), he has modified this method by mixing one volume of urine with 5 to 6 volumes of absolute alcohol, previous to the addition of the sulphanilic acid mixture, filtering, and then adding the acid mixture to the filtrate.

I have found it convenient to add about 50 cc. of absolute alcohol to 10 cc. of urine, filtering, and then running into the alcoholic urine, which has become more or less decolorized, the sulphanilic acid mixture from a burette; 20 cc. of the latter are then sufficient, added to about 30 cc. of the alcoholic urine; the addition of the acid in small quantities, for example, 2 cc. at a time, followed by thorough shaking of the urine, is at times advantageous, especially in typhoid fever, when the disease has advanced to a point at which the color reaction is no longer at its original intensity. By the addition of a few drops of ammonia to the final mixture, the characteristic color appears in typhoidal urine to disappear on shaking, and to become permanent after an excess of the ammonia has been added.

I have found a small Erlenmeyer's flask more convenient for holding urine than the ordinary test-tube, the exact shade of color being more apparent by transmitted light. With this modified method most of my experiments have been performed. There is, however, a third, which I consider more convenient, less expensive, and more delicate. A few cc. of urine are taken in a small test-tube, and an equal quantity of the sulphanilic acid mixture added, the whole being thoroughly agitated; 1 cc. of ammonia is then allowed to carefully run down the side of the tube, forming a colorless zone above the yellow urine, containing the acid, and, at the junction of the two, a more or less deeply colored ring will be seen, the color of which is readily distinguished and noted, the slightest carmine tint being made out more readily by its contrast with the colorless zone above, and the yellow below, than when we are dealing with a uniform color.

This simple modification I recommend particularly, and as it occupies but a few minutes, I am sure it will be found especially convenient by the busy practitioner. As to the color-play which occurs in different kinds of urine, it will be observed that in normal, or pathological, but non-febrile urines, the color of the pure, or alcoholic urines, when method No. 2 is employed, remains either unaffected or is merely intensified by the addition of the ammonia; a deep orange tint may even be produced in this way, but is of no significance whatsoever, and easily enough distinguished from the typical color. Ehrlich records one exception to this general rule, namely, that in urines containing biliary coloring matters, an intensely dark, cloudy discoloration occurs at times which, upon boiling, is changed to an intense reddish-violet color.

In the course of my experiments I have met with another very interesting exception, but regret that I have but one observation to record on the case, which I owe to the kindness of Dr. Ogden of Milwaukee. The urine of this case contained a substance which reduced Fehling's solution, but did not reduce the subnitrate of bismuth, and merely produced a black discoloration, and in which the fermentation test failed completely. Undoubtedly this was one of the rare instances in which glycuronic acid, first isolated by Schmiedeberg and Mayer (*Zeitschrift f. Physiolog. Chemie,* Bd. 3, 1879), occurred normally in the urine. When Ehrlich's test was applied to this urine, according to the second method, described above, a dark brown color developed on standing for a quarter of an hour, which, at the end of an hour, became almost black. As regards febrile urines, Ehrlich observed the production of an intensely yolk-yellow color, which was even imparted to the foam when method No. 1 is employed, in rare instances of endocarditis ulcerosa, abscessus hepatis, and intermittens, especially, *i. e.,* in diseases associated with well-marked chills.

Now, in typhoid fever, and this, of course, is the most important, a color occurs upon addition of ammonia, which may vary from an eosin to a deep garnet. Here I found method No. 2, but particularly No. 3, very useful, because with them the production of the faintest rose-tint is more readily perceived than when No. 1 is employed, owing to the fact that in the second method we are practically dealing with a primarily colorless solution, and in No. 3, as above stated, we can take advantage of the contrasts.

If method No. 1 is used, and there be the least doubt as to the presence of the characteristic color, which may occur in the later stages of typhoid fever, the reaction may be said to be present when the foam which appears on shaking shows a reddish color, and especially when upon standing for twelve to twenty-four hours the superficial layer of the sediment shows a green color. This latter is found to be due to the transformation of the red soluble coloring matter into an insoluble green body. When the color is of its maximum intensity, of course no difficulty is experienced whatsoever in recognizing the presence of the characteristic reaction, the color being then of the most intense carmine or garnet shade.

That this reaction is not dependent upon the presence of any substance, normally present in the urine, that Ehrlich seems to have established beyond a doubt, but as to the nature of the substance producing the reaction we have absolutely no knowledge. It is possible that a careful chemical study of the green sediment will lead to a clue as to the nature of this body, but this, of course, must be left to the hands of chemists.

Ehrlich has tested the urines of patients, afflicted with almost every known disease, and has arrived at negative results, with some exceptions; typhoid fever, of course, being the most important and interesting. At times, however, he has met with the same in some of the morbilli, and diseases in general characterized by high fever, as in severe cases of phthisis pulmonalis, although it may occur in the latter in the absence of fever, but when present for some time he regards it a bad omen.

Although I have tested the urine of almost every disease which has occurred in the medical wards of our hospital, besides a number of specimens taken from healthy individuals, I have only observed it in cases of typhoid fever and phthisis pulmonalis. Not having as yet had opportunity of examining specimens taken from contagious cases, I am unable to express any opinion on these. On phthisis pulmonalis I wish to report at some future occasion. I subjoin a summary of the typhoid fever cases in which Ehrlich's test has been used. The degree of reaction is noted as follows: III signifies very intense; II intense; I marked; Iμ faint.

Case 1.—George N., aet. 35, admitted July 18, the fifth day of disease. Reaction on the sixth, seventh and eighth days. Patient left the hospital before recovery.

Case 2.—Charles B. S., aet. 51, admitted July 2, the fifteenth day of the disease. Death resulted on the twenty-fourth day of the disease. The reaction was very faint on the sixteenth to eighteenth day, and absent on the nineteenth day.

Case 3.—Thomas K., aet. 21, admitted July 8. His primary illness lasted 20 days, and succeeding a period of 7 afebrile days, a relapse occurred lasting 11 days, the case ending in recovery. T=100°–104° F.

On the 7th day of the disease the reaction was III.
“ 8th “ “ “ “ III.
“ 9th “ “ “ “ II.
“ 10th “ “ “ “ I.
“ 11th “ “ “ “ Iμ.
“ 12th “ “ “ “ 0.

Method No. 2 was used. Not tested in the relapse.

Case 4.—Frederick T., admitted July 8. His primary illness lasted 17 days, and succeeding a period of 13 afebrile days, a relapse occurred, lasting 11 days, ending in recovery. T=100.2°-103.5°.

On the 6th day of the disease the reaction was III.
“ 7th “ “ “ “ III.
“ 8th “ “ “ “ III.
“ 9th “ “ “ “ III.
“ 10th “ “ “ “ II.
“ 11th “ “ “ “ I.

Method 2 used. Not tested during the relapse.

Case 5.—Charles E., admitted July 16, with a possible relapse, the fever continuing uninterruptedly for 55 days, and ending in recovery. T=100°–104.5°. On sixteenth day of disease reaction was 0. During relapse present for several days III. Method 2 used.

Case 6.—John M., admitted August 21, the fever lasting 35 days, ending in recovery. On fourteenth day of disease reaction was II.

Case 7.—Joseph D., admitted August 21. Death resulted on the nineteenth day. T=100°–104°.

Reaction on 10th day III.
“ “ 11th “ II.
“ “ 12th “ Iμ.

Case 8.—Mary S., aet. 11, admitted September 9. Her primary illness lasted 27 days, and was followed by a relapse continuing for 12 days, ending in recovery. Method 2 used. Reaction absent throughout. This case and the following, also, occurring in a child, are my only ones in which the reaction, which was expected *a priori*, was negative. Both cases were of considerable severity, the fever remaining between 103° and 105° for some days.

Case 9.—Lizzie X., aet. 12, treated outside the hospital, the illness lasting 23 days. Reaction was not obtained after the eighth day.

Case 10.—Francis H., aet. 10, admitted September 28. Temperature gradually fell from 104° and ended in recovery.

On the 7th day of the disease the reaction was III.
“ 8th “ “ “ “ III.
“ 9th “ “ “ “ III.
“ 10th “ “ “ “ III.
“ 11th “ “ “ “ II.
“ 12th “ “ “ “ I.
“ 13th “ “ “ “ 0.

Case 11.—John B., aet. 19, admitted September 27. T=99.5°-102°, reached 104° once. Recovery.

On the 17th (?) day of disease the reaction was II.
“ 18th “ “ “ “ I.
“ 19th “ “ “ “ 0.

Case 12.—Anton D., aet. 25, admitted September 25. T=100°-105°. Reaction on the thirteenth day Iμ.

Case 13.—Albert S., aet. 55, admitted September 23. On twenty-second day of illness reaction was III; on the fourteenth day the temperature had reached 97.5°-99.2°, probably indicating a pseudocrisis.

Case 14.—James McD., aet. 27, admitted October 15. A critical case, temperature 103°-105°, reduced by baths. Ring method used. Reaction present from fifteenth to nineteenth day II.

Case 15.—Thos. O'D., aet. 23, admitted September 20. T=100°-104°, often reaching 104°. Reaction on fifteenth day I.

Case 16.—John F., aet. 20, admitted October 9. Pseudocrisis on nineteenth day; temperature 100°-104°. On sixteenth day no reaction with method 2. With ring method present II from twenty-first to twenty-fourth day.

Case 17.—Samuel H., aet. 21, admitted October 9. Very mild case; temperature normal from eleventh day. Splenic enlargement still present on sixteenth day with normal temperature. No reaction was obtained.

Case 18.—Timothy M., aet. 24, admitted October 9. T=99°–103°. Reaction present on the seventh and eighth days III; and on the ninth day II.

Case 19.—Otto K., aet. 22, admitted October 6. T=100°–103°. On tenth day reaction I. Ring method, on sixteenth day, Iμ.

Case 20.—James D., aet. 18, admitted October 10. T=99.5°–104°. No reaction on the twenty-second day.

Case 21.—Charles B., aet. 27, admitted October 15.

Ring method on 18th day was II.
“ “ “ 19th “ II.
“ “ “ 20th “ I.
“ “ “ 21st “ I.
“ “ “ 22d “ I.

Case 22.—Robert J., aet. 24, admitted October 7. T=100°–102°. Mild case. Reaction 0 on sixteenth day.

Case 23.—Annie S., aet. 28, admitted October 13. Critical case. T=100°–104.5°.

Reaction with ring method III on 5th day.
“ “ “ “ III “ 6th “
“ “ “ “ III “ 7th “
“ “ “ “ III “ 8th “
“ “ “ “ III “ 9th “
“ “ “ “ II “ 10th “

Case 24.—Maggie B., aet. 19, admitted October 13. T=100°–105°. Critical case. Reaction with ring method present from fourteenth to twenty-first day III–II.

Case 25.—Clara W., aet. 24, admitted October 28. T=100°–104.

Method 2; reaction present on 5th day III.
“ “ “ 6th “ III.
“ “ “ 7th “ III.
“ “ “ 8th “ I.
“ “ “ 9th “ I.

CASE 26. — Ed. Y., aet. 13, admitted October 14. T=101°-104°.

Reaction present on 7th day III.
" " " 8th " III.

From these cases it will be seen that the reaction was only absent in four cases, of which two were the children above mentioned, one a very mild case, lasting but eleven days, and one tested on the sixteenth day of the disease, at a time when the reaction is not always obtained and, in fact, is usually absent.

CONCLUSIONS.

First. The reaction may be obtained in cases of typhoid fever from the fifth to thirteenth day without any difficulty with methods 1 and 2.

Second. With method 3 it may be observed as late as the twenty-second day, at a time when neither 1 nor 2 will yield absolute results.

Third. Its absence from fifth to ninth day indicates a very mild case, excepting in children, although this rule is probably not an absolute one.

Fourth. As it occurs previous to the appearance of the rash, it is a very useful aid in the diagnosis in typhoid fever. —*The Johns Hopkins Hos. Bulletin.*

THE CENTENARY OF THE MICROSCOPE.

BY ERNESTO MANCINI.

Nuova Antologia, Rome, December.

It is generally thought that the invention of the microscope goes back to the close of the fifteenth century, or, to be more precise, to the year 1590, when, in the city of Middleburg, in Holland, two spectacle-makers, named Janssen, invented both the telescope and the microscope. This date for the invention, according to which its third centenary would arrive in 1890, does not rest on authentic documents, but is based on assertions published in 1665 by the physician, Peter Borel. He denied that Galileo, Drebbel, and others, deserved the credit of having invented the telescope ; and in order to demonstrate that the invention of that instrument, as well as of the microscope, was due to the Janssens, produced some documents which showed that the two spectacle-makers, having invented the telescope in 1590, presented a specimen of it to Prince Maurice, Stadtholder of the Netherlands, and to the Archduke Albert. Later on, however, the telescope of Prince Maurice became a microscope, in a letter of William Borelli, who declared that he had always heard in Middleburg, his native city, that the Janssens had invented these optical instruments, and further that, when he was ambassador at London, in 1619, he had seen in the hands of Drebbel the identical microscope that the Janssens had presented to Prince Maurice.

Professor Govi, however, in a work which demonstrates the excellence of his judgment and his vast erudition, has collected a series of documents, which not only seem to restore the merit of the invention of the microscope to Galileo, but show the various vicissitudes of the discovery itself. The first hint of the transformation of the Holland telescope into a microscope is found in a little book published in 1610 by Wodderborn, a pupil of Galileo. Speaking of the wonderful qualities of the telescope, Wodderborn adds, in praise of Galileo, that "with the instrument could be perfectly distinguished the organs of motion and sensibility in the smallest animalcule," so that the particular formation of multiplied eyes in very small animals could be perceived. This new application of the telescope by himself Galileo did not deny, though he never directly affirmed it. In the National Library at Paris is preserved a letter by Canon Tarde, in which he speaks of visiting Galileo in Florence, in 1614, when the latter was sick in bed. Notwithstanding, to Tarde Galileo gave ample explanation of a microscope then in his possession.

Whether the invention of the simple microscope be due to Janssen or Galileo, to Drebbel is due the merit of having produced at Rome, in 1624, the compound microscope. The difference between the two hardly needs explanation. The simple microscope magnifies with a single lens, or with several lenses so close together that they act like a single lens. The compound microscope has two or more lenses, separated by a convenient distance from each other, and which act separately. In 1669, Eustachio Divini constructed a colossal microscope which magnified 140 times. A little after, Bonannus invented a horizontal microscope which magnified 300 times.

In the seventeenth century were laid the foundations of micrography, a science which, by the study of the minute anatomical elements and their functions, has made such great progress under the name of histology, and been such a fertile cause of important discoveries. With the microscope, Malpighi, by the minute examination of the tissues, confirmed the theories about them he had previously formed ; Leuwenhœk discovered the globules of the blood and the structure of the nervous fibres ; and Swammerdam dissected insects, of the most minute organs of which he gave descriptions still considered perfect.

In the eighteenth century, observes Henocque, but few modifications were made in the microscope. To mention all the improvements made in the instrument during our century would be tedious. During the last forty years enormous advances have been made in science by the aid of the microscope, of which the usefulness has been greatly increased by the skill with which the matter to be examined is prepared, and by the aid of photography. Microphotography dates from 1840 only ; but since that date it has had an uninterrupted series of noteworthy improvements.

Besides histology, created by the microscope, by which our acquaintance with the most hidden structure of organisms is constantly increasing, bacteriology, with its rapid succession of discoveries of the highest importance, owes its existence to the microscope. Those little beings, those micro-organisms, which, by the change of the medium in which their evolution is effected, can produce so much good or so much evil, and of which it takes several millions to occupy the tenth part of half an inch in space, can now be identified according to their species, notwithstanding their changeable aspect. We can estimate the rapidity of multiplication, the number, the dimensions, and the singular manner in which by dividing themselves, or by means of a sort of buds or spores, the micro-organisms reproduce themselves.

In the examination of the inorganic world the microscope has had results not less precious. The wonderful phenomena of crystallization, the exact form of the crystals, the more precise in proportion to their minuteness, the modifying properties of the light called forth by the thinnest layer of a mineral, the interior texture of rocks, all these can be studied with a precision impossible before the invention of the improved microscope. And, finally, not to mention all the triumphs achieved by the instrument, it has had an application which formerly would have seemed paradoxical, since the microscope has been employed to show the particulars of the nature of the surface of the planets, particulars which have been made clear by microscopic observations of instantaneous photographs.—*Literary Digest.*

SCIENTIFIC GLEANINGS.

EFFECT OF THUNDERSTORMS ON MILK.—The effect of thunderstorms in turning milk sour is a matter of constant observation in every household. It is not certainly known to what element in the air this souring action on milk is to be directly attributed, and most people are content to ascribe it to "electricity in the air." An Italian savant, Professor G. Tolomei, has lately made some experiments with the view of elucidating this question. He found that the passage of an electric current directly through the milk not only did not hasten, but actually delayed, acidulation,—milk so treated not becoming sour until from the sixth to the ninth day, whereas milk not so electrified became markedly acid on the third day. When, however, the surface of a quantity of milk was brought close under the two balls of a Holtz machine the milk soon became sour, and this effect he attributed to the ozone generated ; for when the discharge was silent the milk soured with greater rapidity than when the discharge was explosive,—in the former case more ozone being formed than in the latter. The souring of milk is generally attributed to the growth of a ferment (bacterium), which converts the milk sugar into lactic acid. It is possible, then, that the presence of ozone in the air overlying the milk hastens the growth and multiplication of the bacterium. The first observation, namely, the retardation of souring by the passage of a current through the milk, may be a point of practical importance to milk traders. Regarding this theory that milk becomes sour from the action of ozone, Dr. Henry McClure (*British Medical Journal*) contends that there must be some mistake. He writes: "One can hardly imagine that this gas, which undoubtedly possesses powerful oxidizing and antiseptic qualities, should be the factor in producing this result. The result may be admitted, but viewed in relation to the experiments of Professor Lodge, confirmed by myself, on the precipitation of smoke by the static spark, and stated in my book on 'Static Electricity in Medicine,' it is a fair inference that the atmospheric dust, together with organic germs, are thus precipitated during a thunderstorm, the precipitation of the latter causing the rapid souring of milk, the putrefaction of meat, etc.; and thus there seems a scientific basis for the popular belief that electrical storms clear the air."—*Druggists Circular*.

SCHOLL ON INVESTIGATIONS INTO CHOLERATOXINES.—The conclusions of the author's experiments, made in the Hygienic Institution of the (German) University of Prague, are as follows: "The toxic peptone which I have produced from genuine albumen, after its destruction by anaerobiosis, is quite distinct from Petri's toxo-peptone (formed by aerobiosis) because the latter is not destroyed by boiling, while mine is rendered inert. My choleraicpepto-toxine shows far more poisonous and characteristic properties than the toxines of Brieger and Petri formed by aerobiosis in peptone solutions, for the toxine which I procured (by the cultivation of cholera bacilli) from a single egg was sufficient to kill ten guinea-pigs in ten minutes with acute paralytic symptoms. The assertion of Hueppe and Wood, that more and stronger toxines are formed by cholera bacilli by anaerobiosis than by aerobiosis, is fully confirmed by my experiments, which negative the opposite assertions of Petri." —*London Medical Recorder*.

BEHAVIOR OF THE VIRUS OF CHOLERA, ENTERIC FEVER, AND OF TUBERCULOSIS IN MILK, BUTTER, WHEY AND CHEESE. Milk having been shown to be a vehicle for the transmission of certain diseases, *e. g.*, scarlet fever, enteric fever, cholera and tuberculosis, Dr. L. Heim made experiments to ascertain the duration of viability of certain disease germs when cultivated in milk or the food-stuffs prepared from it, butter, whey and cheese. The author's results show that the germs were still capable of development in

	Cholera.	Enteric Fever.	Tuberculosis.
Milk after	6	35	10 days.
Butter "	32	21	30 "
Curds "	0	1	2 "
Whey "	2	1	14 "
Cheese "	1	3	14 "

—*Journal Royal Microscopical Society.*

PEROXIDE OF HYDROGEN AS A STERILIZER OF MILK.—Dr. Heidenhain (*Centralblatt f. Bakt. u. Parasitenkunde*), referring to Dr. Altehoefer's researches on the use of peroxide of hydrogen in the disinfection of water, says that it may also be useful for sterilizing milk, although he is not able to say as yet how the digestibility of milk so treated will be affected. He finds that children take it readily, and that the peroxide, mixed in the proportion of five or six tablespoonfuls to one litre of milk, does not cause the milk to curdle or to become sour, even when it is left in a room at summer temperature for forty-eight hours, the slight acid reaction with litmus paper being due to the action of the disinfecting material and not to the production of lactic acid. The cream that rises is so sweet that butter cannot be made from it for a very considerable length of time.—*Druggists Circular.*

PATHOGENESIS OF TETANUS.—Faber (*Berliner Klin. Wochenschr.*) has separated by filtration, from pure cultures of virulent tetanus bacilli, a substance that is wholly free from germs, and yet when it is injected into animals, either in the cellular tissue or blood, it produces the clinical picture of tetanus. There seems to be a certain latent period, before the production of the symptoms, that varies with the virulence of the culture from which the extract is prepared. When injected into the blood it produces general convulsions; when into the cellular tissue these are associated with local convulsions. No specific immunity could be determined as a result of the injections.—*Jour. Am. Med. Ass'n.*

TECHNIQUE.

INTRODUCTION OF A UNIVERSAL SCALE OF MAGNIFICATION OF MICROSCOPICAL FIGURES.*—M. P. F. Reinsch complains that every micrographer makes use of an arbitrary scale for his figures. The camera obscura gives, for the same combination of objective and eye-piece, a constant magnification of the object figured; but the microscopes of different makers differ widely, and the magnifications of the systems of objectives and eye-pieces do not vary in the same proportion. Consequently, the statement as to the eye-piece and objective employed, made by authors on their figures, conveys little meaning to those who have not the same microscope at their disposal.

In the systematic description of microscopical plants, it is of the utmost importance to give the dimensions in absolute value. For microscopical work such as this, the micron μ has been chosen as the unit of measure. A scale of magnification should be also based on the same unit. Measurements are indispensable in order to compare specimens of algæ and microscopic fungi with the published figures, but the work is complicated by the variety of magnifications used by authors, and long calculations are often necessary in order to find the absolute numerical values required.

To draw figures in conformity with the base of the measurements, the microscope must be brought to the desired magnification.

Taking μ as unit, the following magnifications are recommended:

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* Bull. Soc. Bot. France, 36 (1889) p. 207.

Magnifications in μ	Coefficients.	
2500	(dimens. of the figure) divided by 2.5	$=n\ \mu$ (absolute value).
2000	" 2	$=n\ \mu$
1500	" 1.5	$=n\ \mu$
1000	multiplied by 1	$=n\ \mu$
500	" 2	$=n\ \mu$
250	" 4	$=n\ \mu$
200	" 5	$=n\ \mu$
125	" 8	$=n\ \mu$
100	" 10	$=n\ \mu$

Only those coefficients are practicable which, multiplying or dividing 1000, give whole numbers as product or quotient. Magnifications greater than 1000 are obtained by multiplying, those less than 1000, by dividing 1000 by the coefficient. The above scale, which represents the magnifications which it is in this way possible to express in whole numbers, will answer all the requirements of microscopical figures.—*Journal of the Royal Microscopical Society*, December, 1890, p. 787.

INFLUENCE OF COLORING MATTERS ON SPERMATOZOA.*—Dr. Emma Leclercq gives the following tabular statement as to the effects of various reagents on spermatozoa (*Jour. R. M. Society*):

COLORING MATTER.	RESULTS.	
	On Nucleus.	On Accessory Corpuscle.
Carmine alone (Frenzel)	Light carmine	Pale Rose
Carmine alone (Flemming	Rose	Red
Renault's hæmatoxylin	Violet	Deep violet
Ranvier's picrocarmine	Rose	Orange
Ehrlich's violet and eosin	Violet	Rose
Ehrlich's violet and carmine	Violet	Rose
Picrocarmine and methyl-green	Violet	Carmine yellow
	(The spermatozoa being green)	

PRESERVING LOWER ORGANISMS IN MICROSCOPICAL PREPARATIONS.—Pure blood serum is recommended by Dr. W. Migula as a suitable medium for examining and preserving delicate animal and vegetable objects. He uses the commercial blood serum, and filters in an ice box, through bibulous paper, frequently changed. The filtrate is mixed with 10 per cent. pure glycerine, and incubated at 45° to 50° C. When all the water has been evaporated, the glycerized jelly is preserved in stoppered vessels. When required for use, a small quantity is dissolved in 10 to 15 times its volume of distilled water, and a large drop placed on the slide. Into this drop the living organism is pipetted, and then the slide is placed in an incubator at about 50°, in order to thicken down the fluid. When of the right consistence, the cover-glass, moistened with a mixture consisting of 40 parts glycerine, 20 parts absolute alcohol and 40 parts water, is imposed. The preparation is again heated for a couple of hours, and then ringed round.—*Journal of Royal Microscopical Society*, December, 1890, p. 804.

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* Bull. Acad. Roy. Belg., 60. (1890) p. 138.

MISCELLANEOUS.

DISINFECTION BY SULPHUR.

There has been much discussion recently respecting the efficiency of sulphur as a disinfectant for various infectious diseases, the efficiency of this method of disinfection having been denied by some physicians whose opinions have been widely quoted in the newspapers. Confirmatory of the results obtained by the State Board of Health of Michigan, we are glad to be able to quote the following from a work by Dujardin-Beaumetz, entitled *Les Nouvelles Medications* :—

"Twenty grams of sulphur to a cubic metre (1.53 lbs. per 1,000 cubic feet of air space) destroy the different micro-organisms in a moist state, but it is necessary to increase this dose if one wishes to destroy some organisms in a dry state. In fact since the last communications to the Academy, M. Bardet and myself, aided by M. Chambou, have continued these experiments upon micro-organisms in a dry state, and particularly upon vaccine virus. We have taken from the pustules of vaccinia scabs which we have reduced to fine powder, and placed in chambers where were variable quantities of flowers of sulphur. When a dose did not exceed 20 grams per cubic metre, the vaccine powder did not lose its properties, and one could, by inoculating animals and infants, obtain a vaccine eruption.

"With 30 grams per cubic metre (2.297 lbs. per 1,000 cubic feet of air space), the results obtained were uncertain, sometimes the powder losing its properties; but when the dose is increased to 40 grams per cubic metre (3.06 lbs. per 1,000 cubic feet of air space), the inoculations are always inactive. So, then, for vaccine, and probably for variola, if one desires to destroy the contagious 'germs' in a dry state, it is necessary to double the dose of 20 grams which we have already fixed.

"According to the experiments of Vallin and of Legouest, 20 grams are sufficient for typhoid fever, while, according to Vallin, 40 grams are necessary for the microbe of tuberculosis."—*Hall's Journal of Health.*

TREATMENT OF DIPHTHERIA BY IODIDE OF POTASSIUM.

S. Zinenko has obtained very encouraging results by the internal administration of iodide of potassium in diphtheria. It is administered to adults in doses as high as sixty grains a day; children aged from one to fourteen years are given, each day, twice as many grains as they have years. The remedy is continued until the appearance of symptoms of iodism, which is generally noticed from the second to the fourth day of the disease. In case of cardiac weakness, tonic treatment is given at the same time. The author uses neither applications nor cauterization to the throat, as he considers them both irritant and useless. On the other hand, he employs the atomizer with a solution of boric or salicylic acid of from two to three per cent. The same is also to be used as a gargle. With children he uses lavage of the pharynx, according to the method of Dr. Stegenski. All the patients receive frictions of mercurial ointment in the region of the sub-maxillary glands (twenty-two grains, twice daily). Toward the end of the treatment, hydrochlorate of quinine is given for its tonic effect. This method has been applied in all to twenty-eight persons. Some of the patients died. At the same time, in another service of the hospital, where the patients are treated by other methods, sixteen deaths occurred out of twenty-nine cases. In another hospital, where the hygienic surroundings are better than in the service of the author, during the same epidemic, the mortality was fifty per one hundred.—*Bull. Gen. de Ther.*

SMALL-POX.

Permit me to call attention to a plant which I have had frequent opportunity to prescribe in small-pox, and which possesses more remarkable virtues than any other remedies in the treatment of variola. I allude to *saracenia purpurea* which grows in North America and the common name of which is pitcher plant, huntsman's cup, etc. It has the power to abort the variola, and to cure it in a few days. If it is given during the period of incubation the disease will not be developed. If it is given when the eruption is fully out, a few doses will cause the papules to become pale, to diminish in size, and to disappear so completely that in ten days no trace of them will be left.—*Dr. P. Balmoussieres in Clinique.*

MICROBES IN OTITIS MEDIA.

Drs. A. Maggiora and G. Gradenigo (*Centralbl. fur Bakt. u. Parasitenk.*, Band 8, No. 19, October 30, 1890) mention the results of researches of previous authors, and then give their own methods of examination. They find that by covering and plugging the end of a silver sterilized Eustachian catheter, it may be passed into the Eustachian tube, without becoming contaminated by the nasal mucus. The plug is withdrawn by means of a thread, and a celluloid bougie—which had been sterilized by repeated energetic rubbing with sterilized cotton wool—is introduced for at least 1 centimetre into the tube. The bougie is withdrawn, and then placed in tubes containing gelatine and agar, and plate cultivations are prepared in the ordinary manner. In thirteen cases of chronic middle ear catarrhal inflammation with thickened membrane, fifteen ears were examined with the following results: Micrococcus candicans was found in six out of the fifteen cultivations; saccharomyces roseus in four; saccharomyces ellipsoideus, bacillus subtilis, micrococcus cereus albus, penicillium glaucum, and diplococcus citreus conglomeratus in two each; sarcina lutea, micrococcus citreus (II), bacillus albus, micrococcus cereus flavius, sarcina alba, merismopedia aurantiaca, and micrococcus opalescens in one each. In one case nothing was found, and in one non-pathogenic organisms that liquefied gelatine were met with. The authors conclude that in the later chronic or dry stages of middle ear inflammation there is no evidence of the presence of pathogenic organisms, as all those mentioned above may be looked upon as entirely innocuous. As regards the earlier stages, although there is nothing proved as yet, they consider it is quite possible that specific infective organisms may play some part, as their experiments are not at all inconsistent with such a condition.—*British Medical Journal.*

TUBERCULAR INFECTION FROM MILK.

Courtenay De Kalb, writing to the *Nation* from Eastern Peru, says: "Cattle are raised here solely for beef, milk never being used. It appears that in the tropics milk is even more likely to be infected with the bacillus tuberculosis than in the north, and so many cases of consumption have been traced to its use, that the entire population, with scarcely a single exception, leaves it absolutely alone.—*Druggists Circular.*

REMEDIES AND CLINICAL NOTES.

ABORTIVE TREATMENT OF HERPES, AFTER PROF. LELOIR.

℞	Resorcine	ʒ ss.
	Alcohol 90°	℥ iij & ʒ j.

If the pain is very severe he recommends:

℞	Hydrochlorate of Cocaine	grs. xv.
	Ex. Cannabis indica	
	Essence of Mint aa	ʒ ijss.
	Alcohol 90°	℥ iij & ʒ i.

Cover the diseased parts with impermeable cover, then dampen a light cloth or gauze with one of these solutions and apply it over the whole region.

CURATIVE TREATMENT OF HERPES.

℞	Aristol	
	Resorcine aa	ʒ ss.
	Tarro-petrolene (or Petroleum Com. No. 1)	℥ iij.

Ft. Oint.

Sig.: Apply twice daily over the diseased region.

Fowler's solution of arsenic may be used besides, internally.

URTICARIA.

℞	Iodol	
	Chloral aa	ʒ ss.
	Tarro-petrolene No. 1	℥ j.

Ft. Oint.

Sig.: Apply twice daily in gentle friction.

Mr. Quinquaud advises camphorated alcohol with a little chloroform and water in extreme itchiness. Internally he prescribes arseniate of soda.

SORE MOUTHS OF NURSING WOMEN.

℞	Katharmon	f. ℥ ii.	
	Glycerini	f. ʒ ii.	
	Aquæ Menth. Pip	f. ℥ ii.	Misce.

Sig.: Use as a mouth wash two or three times a day.

SYPHILITIC SORES IN THROAT, ETC.

℞	Listerine	ʒ 1 to 3
	Glycerine	℥ 2
	Salt	grs. 5 to 10. Misce.

Or :

℞	Listerine	ʒ 2.
	Aquæ	℥ 10.
	Sodii Bicarbonate	grs. 5.
	Sodii Biborate	grs. 5. Misce.

—*Dr. Carpenter, in Medical Brief.*

QUERIES AND ANSWERS.

Under this heading we will answer, as briefly as possible, short, concise, rational questions of subscribers, concerning bacteriological subjects *only*, as far as our knowledge may afford.

Q. It is stated that pyoktanin is non-poisonous ; how then does it act as a germicide ? Sub. St. Louis, Mo.

A. It seems to act by virtue of its staining properties ; it fixes itself on and throughout the body of bacteria, and thus destroys their vital energy.

Q. What technical work would you recommend for use by a beginner in the study of bacteria ?

A. There are several good books, and each has its special value. Get catalogues from medical book publishers. For one versed in histological technique, *Salomonsen's Bacteriological Technology* is an admirable treatise. It is published by Wm. Wood & Co., New York. I would recommend beginners to read Prudden's "Story of Bacteria" published at 75 cents by G. P. Putnam's Sons, New York.

Q. To what species of beings belongs the parasite of malaria, as given in the illustration of the February number ?

D. V. S., Chicago, Ill.

A. From all that we know so far (the study is not complete), it seems that the parasite belongs to the *gregarina*, a genus of *protozoa*, family *gregarinidae.*

PUBLICATIONS.

NOTICE OF SPECIAL PUBLICATIONS.

BY PAUL GIBIER, M. D.,

Collaborator of The Bacteriological World. Director New York Pasteur Institute.

IN FRENCH.

Persistence of the Foramen of Botal (interauricular orifice.) *Soc. Anatom.* Paris, 1880.

On Tuberculosis of the Testicles. *Soc. Anatom.* Paris, 1880.

On Cysts of the Ovary (patholog. anatomy). *Soc. Anat.* Paris, 1880.

On Syphilis. Late Secondary Lesions. *Soc. Cliniq.* Paris, 1881.

On Syphilis. Unusual Situation of the Primary Lesions. *Union Medicale.* Paris, 1881.

On Pulmonary Wounds by Fracture of the Clavicle. *Soc. Clin.* Paris, 1881.

On Syphilis. Excision of the Initial Ulceration at its Beginning. *Soc. Clin.* 1881.

On Typhoid Fever. Paris, 1881.

Paralytic Symptoms Produced by Lightning. *Soc. de Biologie.* Paris, 1881.

On Typhoid Fever. Parasitic Spots. *Soc. de Biolog.* 1881.

On Cerebral Tumor, etc. *Soc. Anat.* 1881.

On Anatomical Pathology of the Right Heart. *Soc. Anat.* Paris, 1881.

Bacteria of the Pemphigus Acutus. Researches demonstrating that the Pemphigoid Fever is caused by a Specific Bacteria. *Annales de Dermatologie.* Paris, 1881.

On Dermoid Cyst of the Fingers. Paris, 1881.

On Enteroclysmus. Experiment. Research. *Union Medicale.* 1881.

On Anthrax. Possibility of Infecting the Cold-blooded Animals by Artificial Elevation of their Temperature. *Academie des Sciences.* Paris, 1882.

Action of Cold upon Trichina. In collaboration with Prof. H. Bouley, President of the *Academie des Sciences.* Paris, 1882.

Hydrophobia (Experiment. Research on). Its Inoculation, Hereditary Transmissions, etc. *Academie des Sciences.* Paris, 1883.

Hydrophobia. Its Microbe. *Academie des Sciences.* 1883.

Hydrophobia. Effect of the Cold on the Conservation of its Virus. *Ib.*

Hydrophobia. Birds Contract and May Transmit it, but Recover. *Ib.*

Hydrophobia. Experiment. Researches, etc. (One Volume.) Asselin & Houzeau, publishers, Paris, 1884.

On Hydatid Pulmonary Cysts. In collaboration with Prof. V. Cornil of the *Faculte de Paris. Soc. Anat.* 1883.

On Cholera. From a report presented to the French Government, which intrusted the author with the mission of studying the epidemic of France, 1884. Paris. (Exhausted edition.)

On Vaccination of Cholera. Experim. Research., in collaboration with Dr. Van Ermangem, of Gand. *Acad. de Med.*, of Paris, 1885.

Hydrophobia. Attenuation of its Virus by Passage through the Organism of the hen. *Soc. de Biolog.* 1885.

On Primitive Virulence of Venereal Adenitis. *Soc. de Biolog.* and *Annales de Dermatologie.* 1885.

Report to the French Government on the German Laboratories of Bacteriology (official mission). 1885.

Report to the French Government on the Cholera in Spain (official mission). 1885.

Psychical Researches. Spiritism and Fakirism. A Vol., 400 p., with engravings. Paris, 1886.

On Disinfection by Steam without Pressure. *Academie de Medicine.* Paris, 1886.

Yellow Fever. Experimental Investigations made in 1887–1888 in Havana. (Official mission of the French Government.) *Acad. des Sciences* and *Acad. de Med.* Paris, 1888.

Yellow Fever. Its Etiology; Its Treatment. *Bulletin Medical.* Paris, 1888.

Bacteriology. On a New Process of Cultivation in Matrasses in order to Isolate the Microbes. *Acad. de Med.* Paris, 1888.

Consumption. On a New System of Inhalations. *Acad. de Medecine*, of Paris, 1888.

Action of Cold upon Trichina. Refrigeration has no Effect. *Acad. des Sciences.* Paris, 1889.

Analyse des Choses. (Psychology.) One Volume. Paris, 1889.

IN SPANISH.

Fiebre Amarilla. Experiment. Research on Etiology and Treatment of Yellow Fever. *Acad. of Sciences of Havana. Cronica Med. Quirurgica de la Habana*, etc. 1888.

Fiebre Amarilla. Sobre el tratamiento de la fiebre amarilla (Treatment of yellow fever.) *Cronica Med. Quirurgica de la Habana.* 1888.

IN ENGLISH.

Yellow Fever. *Gaillard's Medical Journal*, of New York, February and March, 1889.

Anti-rabic Inoculations. Mechanism of Immunity. *American Medical Association.* 1890.

The Pasteur Treatment. *North American Review*, August, 1890.

Dr. Koch's Discovery. *North American Review*, December, 1890.

The Principles of Anti-rabic Vaccination. *Bacteriological World*, January and February, 1891.

Three communications to the Berlin Medical Congress in 1890. *First.* A new theory about temperaments. *Second.* Peroxide of hydrogen anti-septic properties. *Third.* Hydrophobia.

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DANIEL MORTON, M. D.,
EDITOR.

SELF-PURIFICATION OF FLOWING WATER.—A reprint of a biological study on this subject, by Dr. Chas. G. Currier of New York, and which was published in the *American Journal of Medical Sciences* has reached our office. It is a very interesting and useful contribution to hygiene, containing, as it does, much information showing the influence of polluted water in the causation of disease. It contains a number of tables giving the ratio of bacteria per cc. in the water of many rivers and hydrants. The author deserves much credit for his splendid presentation of so many useful facts in so small a space.

THE STORY OF BACTERIA, AND DUST AND ITS DANGERS.—These two excellent little works of Prudden on bacteria, which we reviewed in February number, are published by G. P. Putnam's Sons, New York and London, at 75 cts. each.

ITEMS AND NOTES.

THE ST. LOUIS COLLEGE OF PHYSICIANS AND SURGEONS.—Dr. A. S. Barnes informs us that their "ad." in last issue is erroneous as to date. The Spring term begins March 15th, and the winter term the 10th of September. We are sorry to have been so misled by the manuscript as to publish the wrong dates. See advertisement on the last inside cover page.

THE ST. LOUIS CLINIQUE.—By mistake in our last issue, the notice of the improvement in the dress of this excellent medical publication was erroneous in its heading. It was entitled La Clinique instead of the St. Louis Clinique, as it should have been.

DR. HENEAGE GIBBES.

THE BACTERIOLOGICAL WORLD

A Monthly Illustrated Magazine Devoted to the Study of Micro-Organisms and Specific Maladies.

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Vol. I. COLUMBIA, MO., U. S. A., APRIL, 1891. No. 4.

EDITORIAL.

CONCERNING RACES AMONG BACTERIA.

Mr. M. C. Gessard in his work on biological chemistry at the Sorbonne and Pasteur's Institute, Paris, established that the *pyocyanic bacillus,* in its chromogenic function, produced a variety of pigments according to differences in the compositions of various culture media. His first investigations were made* with a micro-organism isolated from the dressing (of a wound). Afterwards he studied the functions of two other organisms of different origin. In the course of these studies Mr. Gessard investigated the measure, constancy and the question of necessity of relation between microbe and medium in the production of pigment; if these relations could extend to other germs of whatever source; if exceptions could not spontaneously occur; or if forms could be provoked artificially and perpetuate themselves afterwards by way of generation. In other words he asked himself the question, can there be different races of the pyocyanic bacillus?

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* Annales de l'Institute Pasteur, T. IV, page 88.

The idea of races among micro-organisms of the same species was introduced by Pasteur during his study of alcoholic fermentation (as far back as 1862). He demonstrated the distinction between "high" and "low" yeast of breweries, probably originating from a unique germ, "illustrating a new example of those modifications of plants and animals which have become hereditary by a prolonged domestication."

Mr. Gessard has concluded from his investigations—and his conclusions are sustained by the careful experimentation of Wasserzug*—that races are established among germs. Both of these scientists have seen that these functions of pyocyanic bacilli and other germs may be modified, altered, changed in such a marked degree as to render their identification with the primitive parent organism difficult without a long series of cultures in various conditions and media. Indeed, we have seen ourselves that even the forms may be changed by surroundings and nourishment.

A same species, in course of development and successive generations may, according to variation of external influences, nutrition and medium of existence, produce a number of germs different in physiological functions, and sometimes slightly in morphology. These altered organisms may be afterward cultivated and preserved with the *acquired* modification, seemingly by hereditary transmission. These microbes with different attributes, coming from an original common parent, are true races, and the knowledge of the process of evolution in producing the alterations—a process that the eye can follow clearly, down the scale of degeneration or upward to a higher physiological condition, perhaps—offers much food for reflection concerning the evolution of higher species in the animal and vegetable kingdoms. The truth of the profound changes produced gradually in a given organism by the surroundings, climate, medium of existence, food, etc., which eventually become physiological characters * susceptible of reproduction in descendants are apparent to all observers; but here are little individual unicellular organisms as full of life as more complex beings, in which we can follow the evolution step by step with the eye.

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*Annales de l'Institute Pasteur, T. I. & II.

When we consider that a microbe is thus a unique cell in which life is centered, and that a larger organism—man say—is an aggregation of physiologically related cells, individually endowed with life as the single micro-organism is, we grasp the application of appreciable microbic evolutionary phenomena to more highly organized beings. Are not, in fact, unicellular and multicellular beings closely related physiologically?

From a single kind of bacteria, viz., the pyocyanic bacillus, taken in the dressing of a wound, Mr. Gessard produced, in a series of cultures in different media, carried on successively more than one year, four different races with the following properties:

SPECIES, Bacillus Pyocyanic Races
- A, giving pyocyanine and fluorescence
- B, giving only pyocyanine.
- C, giving fluorescence only.
- D, no fluorescence nor pyocyanine.

VACCINATION AGAINST DIPHTHERIA.

Mr. Fraenkel,† following his researches on the poison of diphtheria, made jointly with Mr. Brieger, has been seeking a mode of vaccination by means of attenuated cultures, and by the use of the toxic products of the microbe of diphtheria.

The best results were obtained with a liquid culture heated an hour at 149 to 158 F. About ten cc. of such a culture, aged three weeks and treated as we have said, confers immunity

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* Mutilations, anatomical sequestration and the like are not considered changes in the sense implied here.

† Berl. Klin. Woch. No. 49, 1890.

against subsequent inoculation of the most virulent virus, on condition that the latter be not practiced sooner than fourteen days after vaccination.

When we reflect a moment on the fearfully toxic properties of the product of this bacillus ; the fact that it lives chiefly on the mucous membrane, whence the poison generated is introduced into the circulation ; that this poisonous matter is the greatest factor in causing pathological phenomena and death, we must admit that vaccination against diphtheria is a most difficult problem to solve. Still, some day, doubtless, diphtheria will be prevented some way.

THE STERILIZATION OF MILK.

The first endeavors to sterilize milk were made chiefly from a commercial standpoint, *i. e.*, to preserve the fluid sweet a longer time. But, as the knowledge of pathogenic germs and the action of ferment organisms became clearer, the suggestion naturally entered the medical mind to sterilize milk from a hygienic and therapeutic point of view, chiefly for the nourishment of infants in health or disease.

A large number of experiments have been made by various experimentalists, with a view to discover the most practicable means of sterilization combining effectiveness, cheapness and harmlessness.

To that end, drug after drug, gas after gas, were tried in vain ; we have still to rely on the action of heat, though perhaps electricity under proper conditions may prove successful. But for every home, for every physician, heating is the only practical process.

To kill *all* the bacteria usually found in milk—and there is always a wonderfully great and diversified army of them—it requires heat a few minutes about 224° F. A special steam sterilizer is necessary to attain such a high temperature. The same effects may be obtained usually by *boiling* the milk about thirty minutes. Heating a few minutes between 158° and 176° is sufficient to *destroy temporarily* the *energy* of a large number of milk microbes including several disease germs, but does *not* *kill* many of them, and is not, therefore, sufficient as a preservative means. This is the temperature (about 167°), the application of which is known as Pasteurization.

Unfortunately for the people, there are yet some medical men who will not concede any dangerous properties to microbes, and a vast number who are in ignorance of the action of germs in milk before or after ingestion.

Is it only to destroy disease germs that sterilization is indicated? By no means. Indeed, in infant-feeding, it is chiefly to prevent the irritative action of acid produced by microbes or germs of all kinds, whether truly milk ferments, pathogenic bacteria, or organisms harmless under ordinary circumstances.

Milk coagulates, acidifies, under the influence of vegetative phenomena of various ferment organisms. The acid produced has the most baneful action on the delicate stomach and intestinal canal of the child. Sterilization of *fresh milk* destroys the property of the germs before any acid is produced by their process of nutrition.

Besides the true milk ferments of various kinds, there is a number of cocci and bacilli which grow in milk. Among the former, there are many which produce acids. Hence they, too, are deleterious and dangerous in the milk fed to the young.

Duclaux, in his researches on the subject, noted that milk sterilized at about 167° F. was about free from acid-producing germs, but still contained live bacilli: a class of microbes apparently more difficult to alter, acting chiefly on the casein, and producing, as a rule, alkalinity instead of acidity. This fact suggested to the mind, that even though the heating of milk be not carried to boiling point it may be very useful in arresting the growth of the acid ferments, and leaving therein the bacilli, causing, by their nutrition, alkalinity of the media. We all know how frequently lime water is administered to bottle-raised babies to counteract the effect of acidity. Theoretically we might, on the same principle, ascribe a beneficial influence to the alkaline-producing microbes left in the milk by pasteurization,—influence, which may be doubly useful because these organisms live at the expense of, and, therefore, reduce, the casein which, in cow's milk, is always in excess of the necessary quantity for very young children.

In the careful, constant use of pasteurized milk there is neither colic, green diarrhœa, or other intestinal disorders so common when using raw cow's milk; but if the milk be highly heated, say at boiling point for several minutes, it is cooked and the casein is affected; it digests well, but there may be some slight colic owing to the hardness of the fœces, and consequent interference with the naturally easy and frequent evacuation of the bowels at a tender age. But there are not any other intestinal troubles.

Pasteurized milk, however, should be used early, for it will not keep long, the germs not having all been permanently arrested; therefore, only careful methodical people can safely utilize it. Thorough sterilization on the other hand is practicable by all who may provide a vessel of some kind to boil water. To heat the milk at any temperature, it may be put in nursing bottles, plugged immediately with clean cotton wool (absorbent cotton), and then the bottles should be placed in a water bath, allowing the water and bottles to heat simultaneously. There are more convenient steam sterilizers manufactured now for the purpose.

We have caused the use of both sterilized and pasteurized milk in a number of bottle-raised children in the last two years with marked success, and we would recommend to doubting physicians the careful study of fermentation, coagulation and digestion of milk, and the effect of pasteurized, sterilized and raw cow's milk on the sensitive digestive organs of the young.

It must not be forgotten, either, that the germs of cholera, typhoid fever, fibrinous pneumonia and others are destroyed or arrested in their pullulation by a temperature not higher even than that used in pasteurization, *i. e.*, 158° to 167° F.

THE TRANSFUSION OF BLOOD AND BLOOD SERUM IN MICROBIC DISEASES.

The transfusion of blood between identical species, and even the transfusion of the blood of sheep to man, had been tested and practiced without accident long before the bactericide properties of blood serum were discovered. Then the operation was resorted to as a tonic treatment,—a method of restoring vital elements to debilitated, weakened organisms. Now it is tested chiefly to counteract the action of bacteria. Needless to say, that, as a germicide, it retains its nutritive properties. Unfortunately, it was found that the transfusion of an animal's blood directly into man's circulatory organs can be practiced only to a very limited extent, owing to pains and reaction resulting therefrom, whilst blood serum *alone* may be injected in a larger quantity without much danger. Consequently, the antiseptic benefits theoretically expected from the action of transfused blood in its natural condition can scarcely be realized. If blood serum acts as germicide and the other elements as nutritive, blood, pure, would seem preferable in debilitating diseases as tuberculosis, for instance, and it is unfortunate they cannot be as effectively used combined. In veterinary practice, however, this objection may not hold good.

At first, blood serum was injected into the system hypodermically, but this method limits its administration to a very small, insufficient quantity, owing to painful swellings and local disorders. Doses of 0.50cc. cause persisting pains when injected beneath the skin in man, whilst he may receive easily, without subsequent accident, 100cc. in a vein.

As a treatment for infectious diseases, it becomes evident that the serum used must proceed from an animal refractory to the disease to be treated ; it must be the serum of blood theoretically or positively known to be inimical to the causative microbe.

With that thought in mind, Dr. St. Hilaire and Dr. Coupard injected serum of dog blood into the trachea in tuberculosis. But dogs, though usually immune against this disease, are occasionally found suffering from it ; tubercles may develop in their system ; their blood, therefore, cannot be considered an absolutely reliable bactericide in the case under consideration. Hence, the trials with this serum are not to be looked upon as positively reliable.

The next serum tried by various experimentalists, in the same disease, was taken from the blood of the goat, a species of animals more refractory to tuberculosis than the dog. Prof. Lepine, of Lyons, France, following on the footsteps of Messrs. Picq and Bertin, of Nantes, France, who had transfused goat's blood in man before, made numerous injections of serum into consumptives.

The serum was quickly separated, aseptically, by means of a centrifugal process, filtered in aseptic filter, placed in a sterilized cylindrical vessel with a funnel-shaped aperture at the bottom, to which a sterilized rubber tube is attached. At the other end of the tube is a spring compressor closing it. A fine sterilized canula is fixed carefully at this end, the serum allowed to fill the tube to its very point in the manner of a hypodermic syringe, and it is introduced carefully into the vein, in the direction of the flow, of course. The fluid must penetrate *exceedingly slowly* under the penalty of serious sudden reaction; if allowed to trickle in very slowly, the quantity introduced may reach 88cc. to 100cc. If some uneasiness, a reaction in other words, manifests itself during the operation, discontinue it. Injections may be repeated every two or three days, a thing impossible in hypodermic injections, owing to local pathogenous results.

The speed of intravenous injection may be regulated readily, by lifting or lowering the supplying vessel more or less above the arm in which the canula is introduced.*

The numerous experiments of Dr. Lepine, on this method of serum infusion, are very encouraging as far as practicability and safety is concerned; it has many undoubted therapeutical advantages over the more simple hypodermic practice, but it remains to be seen whether the serum of goat blood is curative in tuberculosis.

However, Dr. Bompard, Physician in Chief of the General Hospital of Vitry-le-Francois, relates the following results of a recent trial:

"The patient had tuberculosis in the last stages—the third degree; was so feeble that he could not rise; appetite so altered that he ate scarcely anything and retained nothing of the ingesta with the exception of a few teaspoonfuls of coffee.

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*Description of apparatus in detail may be found in pages 146 and 147 of *La Tribune Medicale*, No. 10, March 5, 1891.

Respiration was labored, the surfaces cyanosed, and there was a severe pain of the scapula-humeral articulation preventing all motion of the arm. Forty grams of goat serum were transfused into the right cephalic vein.

"Immediately the face assumed a more pronounced cyanose tinge, nearly black; respiration worse than before; pulse feeble; a cold perspiration covered the face. These alarming symptoms lasted only a very few seconds, and all returned to previous condition.

"In less than two hours afterwards he felt a relief such as he had not experienced for a long time; the pain of the shoulder had completely disappeared; the pulse was fuller, more regular, 100 per minute. Rectal temperature never rose above 38 any time during the day. The first urine passed was highly colored, almost dark.

"The condition since is truly remarkable; appetite, excellent; digestion, easy; strength, increasing, the patient having risen from his prostrated condition and being able to walk about freely. Cough and expectoration have considerably diminished; cyanosis and depression have completely disappeared. All points, in fact, to a radical cure. Still, it is a first case; will it prove a deceptive exception?"

GREEN BACTERIACEES.

Gradually, though with extreme slowness, the gap between bacteria and the next forms in higher organization is closing. The naturalists, with laudable energy and perseverance, are filling the space, narrowing the distance, that separated the species. Already we can appreciate the connecting links between the microscopic species, and in time we will see, probably clearly, the chain of anatomical and physiological relation which binds all living organisms in their respective kingdoms.

Mr. Van Tieghem described, early this year,* two bacteria presenting a green color, supposed to be chlorophyl: The bacterium viride and the bacillus vireus.

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* Note to the Academy of Sciences, January 26, 1891.

More recently* Mr. P. A. Dangeard, Chief of the Botanical Department of the Faculty of Caen, while studying the algæ of soft water, noticed two forms which, "by their behavior and by their endogenous sporulation," fixed his attention. They were constituted by very fine green filaments entangled with one another, apparently devoid of branches, ramifications and partition walls. The content was hyalin, non-granular, and slightly tinged with green, particularly at the moment of sporulation. The chlorophyl, if such is the green matter, was evenly dissolved in the protoplasm.

In process of sporulation some filaments had as many as ten elliptical spores, some of them in groups of three or four. These spores varied between 6μ and 8μ in length, and presented a breadth of about 3μ.

The spores, though formed after the manner of the bacteriacees, do not present absolutely the same features as are known to exist in the common forms of this class of beings. For instance, they do not begin as dark spots, developing at the expense of reserve material of the mother cell, but "it is the entire mass of the protoplasm of the swelled spot which contracts, becomes more and more refringent, and surrounds itself by an envelope.

Klein had observed this kind of sporulation in five forms, which he classed among the genus bacillus.†

Mr. Dangeard proposes, for the forms he describes, the genus *eubacillus*, to impress their close affinity with bacilli. He believes that Klein's forms are of the same order.

HENEAGE GIBBES, M. D.

Dr. Heneage Gibbes, Professor of Pathology, University of Michigan, is the grandson of Sir George Gibbes, physician to Queen Charlotte. Dr. Gibbes commenced life as a sailor, and commanded a gunboat in the Chinese navy for some years.

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* Journal de Micrographie, February, 1891.

† J. L. Klein, Botaniske Bacterienstudien.

On giving up the sea, he entered the medical profession, graduating at the University of Aberdeen, and afterwards at the Royal College of Physicians, London. He commenced the study of normal histology under Dr. Klein before he graduated, and continued this study until he was appointed curator of the Anatomical Museum, King's College, London, where he remained three years and made a thorough study of Morbid Anatomy. He was then invited to take the Chair of Physiology, Normal and Morbid Histology at the Westminster Hospital, London. In 1884, Dr. Gibbes was sent to India by the British Government to make an investigation into the etiology of Asiatic cholera.

In 1887, the University of Michigan determined to institute a Chair of Pathology, which was offered to Dr. Gibbes, who accepted the position, and arrived in Ann Arbor in 1888. Dr. Gibbes was also for nine years physician to the Metropolitan Dispensary in the City of London. During his medical career he has published a large number of original works. He commenced an investigation into consumption in 1882, and in 1883 he was requested by the local Government Board of London to carry on this work for them, the results being published in their reports. On arriving in this country, he lost no time in continuing this work, and enlisted Dr. Shurly, of the Harper Hospital, Detroit, to act with him. Their efforts have resulted in the discovery of a successful treatment for the disease.

Dr. Gibbes has not confined his investigations to consumption, but has published many papers on other diseases. He has been engaged for some years in the investigation into the pathology of cancer, and hopes soon to find a means of arresting that terrible disease.

Bacteriological technique the world over is greatly indebted to this savant, and medical science has in him a most faithful, honored and exceedingly useful apostle. Prof. Gibbes stands high in the front rank of pathologists and bacteriologists of the world.

LESSONS IN BACTERIOLOGY.

LESSON FOURTH.—PART I.

BY PAUL PAQUIN, M. D., V. M.

HISTOLOGICAL TECHNIQUE.

Before the study of bacteria can be profitably undertaken a fair knowledge of histology and pathology is necessary, and the essentials of microscopical technique as applied to botany should have been acquired.

The students should be familiar with the methods of preservation of tissues, section cutting, staining, mounting and the manipulation of the microscope. In our lesson on bacteriological technique we will suppose these subjects known.

The microscope should have a solid base and be steady; a light instrument vibrates too much at the least shaking of the building, floor or table supporting it, particularly when the latter are themselves light or unsteady.

The microscope should be provided with immersion lenses, (oil and water), and an Abbe condenser with a wide angle of aperture. There are a number of reliable houses furnishing excellent stands and lenses in this and other countries. Abbe and Zeiss, of Germany, manufacture, with a special kind of glass, apochromatic lenses which allow stronger oculars, give better results in photography, and present clearer pictures. Still, the best lenses of other houses are often equal to Zeiss apochromatic lenses, and much less expensive.

As in other microscopical studies, a low power should be used in the first survey of the field. A magnification of 50 to 200 diameters with an Abbe condenser, and a diaphragm with narrow diameter will answer the purpose. In thus examining the topography of the sections or other preparations, the stained bacteria may be located by their fixed color, particularly when they are numerous and grouped.

In preparations doubly stained, *i. e.*, with the field one color and the microbes another, the repartition of the latter is comparatively easy to detect; even the bacilli of tuberculosis may be located by such low powers, and large microbes, as the bacillus anthracis, may be individually appreciated. But, to determine the form, species, physical peculiarities of bacteria, clear lenses and a magnification of 300 to 1,500 diameters or more are necessary.

The study of unstained bacteria may be accomplished with high-power lenses and a diaphragm.

The best oil for immersion is pure cedar oil, but impure, thin cedar oil is worthless. In lieu of this, a mixture of chloral hydrate and glycerine may be used to advantage. The lenses should be carefully wiped dry immediately after using, and the microscope covered with a glass bell to protect it from dust and other influences.

ACCESSORIES.—Certain articles are indispensable as accessories in micrographic investigations of bacteria.

First. To clean instruments and glass:—

A chamois skin, soft and smooth.

Old soft rags,—say old linen handkerchiefs.

Second. To handle specimens, etc.:—

Steel needles, (ordinary sewing needles mounted in wooden handles).

Platinum wire needles mounted in glass rods.

Fine forceps with spring, steel or brass.

Spatulas, very thin, mounted in wood.

Pincers with fine, toothless points.

Scissors, fine, curved and straight, for dissection.

Glass rods with one rounded extremity and a more pointed one.

Third. To keep reagents, stains, etc.:—

Flasks, small, with ground mouth for alcoholic solutions and acids.

Flasks, small, with pipettes for stains and reagents used in manipulations.

Bottle cedar oil.

Watch glasses and similar dishes, such as small crystal or porcelain salt-cellars, for staining, etc.

Fourth. Essentials to mount:—

Glass slides, ground edges,—an assortment of different thicknesses.

Cover glasses, round and square, various thicknesses.

Turn table to make rings on slides for special preparations.

Small labels for preparations.
Slide boxes to preserve mounts.

Fifth. Useful in mounting:—

Black glass plate with smooth surface on which to mount.
White porcelain plate for same purpose.
Rubber bulb pipettes.
Camel's hair brushes.
Hand-bulb blow-pipe to dry objects.
Fine white tissue paper (cigarette paper).
Clean white bibulous paper.

MICROTOME.—In histology and botany, satisfactory sections may be made by a careful, steady and experienced hand with a smooth razor; but to diagnose bacteria in sections of tissue necessitates such extreme thinness that few can succeed by free-hand cutting. To obviate the difficulty, various accurate mechanical microtomes have been invented, and are kept in stock by optical houses; satisfactory results are obtained by their use.

To study bacteria in fresh tissues it becomes necessary to freeze the specimens in order to make sections. This is done with ether by the use of a mechanical device accompanying certain microtomes or sold separately.

CAMERA-LUCIDA.—This instrument is needed for accurate drawings of microscopic fields. Drawing pens, pencils, India ink, water colors, brushes, etc., etc., should, of course, be also at hand.

PART II.

CHEMICALS, FORMULAS, ETC.

The bacteriologist or student should always have in stock a certain amount of reagents, stains, etc., necessary to preserve, harden, decalcify, incorporate, fix, stain, mount and examine specimens.

STOCK OF CHEMICALS, ETC.:—

(*a*) Distilled water, renewed frequently, kept in clean stock bottle with rubber tube for exit as represented in Fig. 4.

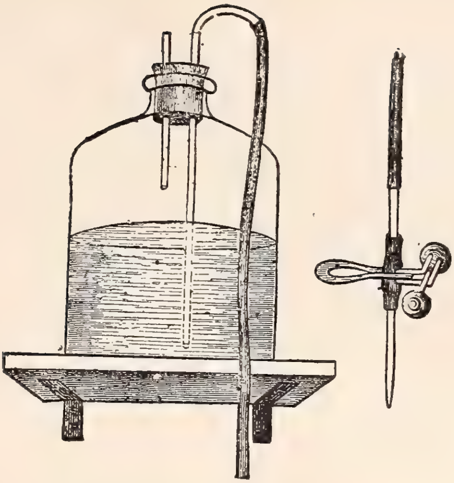

FIG. 4. (FROM CROOKSHANK.)

Glass jar or flask for distilled water for mounting purposes. This reservoir is provided with a glass tube air-inlet (which, if plugged with cotton wool, will admit the air free from germs); a rubber tube syphon with glass dropper and pincers allowing the exit of water in a fine stream.

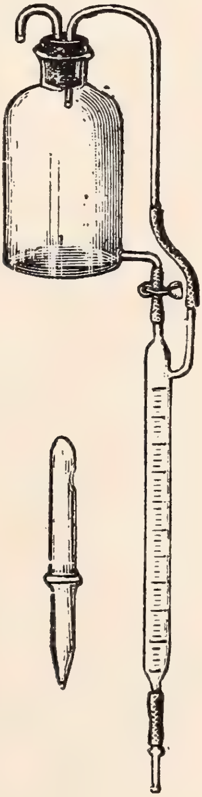

FIG. 5. (FROM CORNIL AND BABES.)
Flask for Sterilized water.

(*a*) Sterilized water. See Fig. 5.

(*b*) Acids, such as nitric, muriatic, sulphuric, acetic etc.

(*c*) Alkalies, as caustic potash, carbonate of soda, ammonia, acetate of potash, etc.

(*d*) Aniline oil used to make aniline water, toluidine used in the same line.

(*e*) Alcohol, absolute and diluted.

(*f*) Cloves oil, or essence, spirits of turpentine; essence of bergamot, oil of origanum.

(*g*) Xylol.

(*h*) Canada balsam.

(*i*) Asphalt gum.

(*j*) Hollis glue.

STANDARD FORMULAS FOR STAINING MOUNTING, ETC.—The following formulas have been adopted by bacteriologists, and are used in various circumstances which will appear as we proceed in the explanation of different methods of investigation, etc. They should be prepared *shortly* in advance, in small quantities, so as to have no old depreciated stock on hand. The fresher the preparations the better as a rule.

Celloidine Solution:—Celloidine, ether, alcohol, equal parts.

Ebner's Solution:—

	(parts.)
Muriatic acid	5
Alcohol	10
Distilled water	20
Chloride of sodium	5

Glycerine Gelatine (*Klebs*):—

Gelatine (1st. quality and well washed)	10
Glycerine	10

Phenol, a few drops.

Add a little distilled water to the gelatine, let it swell, empty the excess of water, melt at mild heat and add the glycerine and then the phenol.

Kleinenberg's Solution:—

Aqueous, saturated picric acid sol.	100
Sulphuric acid strong	2 to 5

Filter and add

Distilled water	300

Muller's Fluid:—

Bichromate of potash	2
Sulphate of soda	1
Distilled water	100

Osmic Acid:—

Distilled water	100
Osmic acid	0.5

This must be kept from light, in a bottle painted black, say, or surrounded by dark paper pasted.

Alcohol	60 per cent.

Acidulated Alcohol:—

Alcohol	100
Muriatic acid	100

Carmine and Alum (*Grenacher*):—

Carmine	1
Alum Solution, a 5-per-cent	100

Boil twenty minutes and filter when cool.

Aniline Water:—

Distilled water	100
Aniline	5

Shake and filter the emulsion.

Bismark Brown:—

(*a*) Concentrated solution made in equal parts of water and glycerine.

(*b*) Aqueous Solution:

Bismark Brown	2
Alcohol	15
Distilled water	85

Borax Carmine:—

Borax	4
Distilled water	100

Add 4 per cent. of carmine, heat twice to boiling point, add equal parts of alcohol at 70 per cent., let settle for five hours and then filter.

Eosine:—

(*a*) Alcoholic solution, saturated.

(*b*) Aqueous solution:

Distilled water	100
Eosine	5

Fuchsine:—

Fuchsine	2
Alcohol	15
Water	85

Gentian Violet:—

(*a*) Alcoholic solution, saturated.

(*b*) Aqueous solution:

Gentian violet	2.25
Distilled water	100

Solution of Gibbes for Double Coloration:—

Take:

Of hydrochlorate of rosaniline	2
Of methyl blue	1

Pulverize or crush in glass mortar;

Dissolve aniline oil	3
In alcohol rectified	15

Add slowly to the first mixture and, last,

Add distilled water slowly	15

Preserve in a flask well corked.

Hematoxylon Solution:—

Hematoxylon	2
Alcohol	100
Distilled water	100
Glycerine	100
Alum.	2

Iodine Solution:—

Pure iodine	1
Iodide of potassium	2
Distilled water	50

Iodine Solution (Gram):—

Iodine	1
Iodide of potassium	2
Distilled water	300

Lithium-Carmine Solution (*Orth*):—

Solution, saturated, of carbonate of lithium	100
Carmine	2.5

Magenta Solution (*Gibbes*):—

Magenta	2
Aniline oil	3
Alcohol (sp. gr. 830)	20
Distilled water	20

Methyl Blue:—

(*a*) Alcoholic solution, concentrated.

(*b*) Aqueous solution :

Methyl blue.	2
Alcohol.	15
Water	85

(*c*) Koch's solution :

Concentrated, alcoholic solution of :

Methyl Blue	1
Potassium solution, 10-per-cent	2
Distilled water	200

(*d*) Lœffler's solution :

Concentrated, alcoholic solution of methyl blue	30
Potassium solution, 1–10,000	100

Methyl Violet:—

(*a*) Alcoholic solution, concentrated.

(*b*) Aqueous solution.

Methyl violet	2.25
Distilled water	100

(*c*) Koch's solution :

Aniline water	100
Alcoholic solution of methyl violet	11
Absolute alcohol	10

Neelsen's Solution:—

Dissolve fuchsine	1
In aqueous solution of carbolic acid, 5-per-cent	100
Add alcohol	10

Orchil (*Wedl*):—

Dissolve pure orchil without ammonia in :

Absolute alcohol	20
Acetic acid	5
Distilled water	40

until a deep red color is obtained, and filter.

Picro-Carmine (*Ranvier*):—

Dissolve :

Carmine	1
In distilled water	10
And ammonia solution	3
Then add : Saturated solution with filtered and cold picric acid	200

Picro-Lithium Carmine (*Orth*):—

To the solution of lithium-carmine mentioned above, add :

Picric acid solution	2.3

Potassium Solution :—

(*a*) 1 to 3 per cent.
(*b*) 10 per cent.
(*c*) 33 per cent.

Safranine :—

(*a*) Alcoholic solution, concentrated.
(*b*) Aqueous solution, 1-per-cent.

Chloride of Sodium Solution :—

0.8 per cent.

Vesuvine :—

(*a*) Alcoholic solution, concentrated.
(*b*) Aqueous solution.

Kuhne's Carmine :—

Alcohol, 80 per cent	50 parts.
Muriatic acid	3 drops.
Carmine	q.s.

Boil ten minutes and filter.

Differential Liquid :—

Distilled Water	10 cc.
Sulphuric acid concentrated	2 drops.
Oxalic acid, 5 per cent	1 drop.

Ziehl's Stains for Tuberculosis :—

(*a*)	Alcohol, absolute	10 cc.
	Fuchsine	1 part.
	Carbolic acid	5
	Water	100
(*b*)	Water	100
	Carbolic acid	3
	Alcohol	5
	Alcoholic solution of rubine	q.s.

Fraenkel's Solutions :—

(*a*)	Distilled water	100
	Aniline oil	3
	Alcohol, pure	5
(*b*)	Aniline oil	30
	Nitric acid	20
	Alcohol, pure	50
	Methyl blue, to saturation	

Gibbes' Magenta Stain:—

Magenta	2 grains.
Aniline oil	3 cc.
Alcohol	20 cc.
Water, distilled	20 cc.

Dissolve the oil in the alcohol and shake. Rub crystals very fine with a little alcohol until all dissolved, then add distilled water, stirring. Keep stoppered, labeled and dated.

Acetate of Potash :—

Concentrated solution.

Farrant's Solution (*Glycerine Gum*):—

Glycerine	Equal parts
Water	
Arsenic acid, sat. sol	
Mix and add : Gum Arabic	1½ parts

Raulin's Fluid, Culture Media :—

	(parts.)
Distilled water	1,500
Cane sugar	70.0
Tartaric acid	4.0
Ammonium nitrate	4.0
Ammonium phosphate.	0.6
Potassium carbonate	0.6
Magnesium carbonate	0.4
Ammonium sulphate	0.25
Zinc sulphate	0.07
Ferrous sulphate	0.07
Potassium sulphate	0.07

Pasteur's Fluid :—

Distilled water	1,000.0
Pure cane sugar	100.0
Ammoninm tartrate	10.0
Ash of yeast.	0.75

Cohn's Fluid, (as recently modified) :—

Distilled water	200
Tartrate of ammonium	20
Phosphate of potassium	20
Sulphate of magnesium	10
Tribasic phosphate of lime.	0.1

(Fifth Lesson in May number.)

ORIGINAL ARTICLES.

KOCH'S TREATMENT OF TUBERCULOSIS.

(From observations abroad.)

BY PROF. WOODSON MOSS, M. D.,
Medical Department Missouri State University.

It is with great reluctance that I attempt, at the earnest solicitation of the editor of this new and valuable journal, to give its readers an article upon the above all-absorbing subject.

Having just returned from a three months' sojourn in Berlin and London, where I had gone, as the representative of the University of the State of Missouri, to investigate the use of Koch's lymph in the treatment of tuberculosis, I have thought, possibly, the best way of presenting an article would be to state what I saw and heard of this treatment, and how I was impressed with it. Upon arriving in Berlin, I found the hospitals easy of access, and the physicians, in charge, kind, courteous and untiring in their efforts to show visitors all they had in their hospitals. The opportunities to observe the use of Koch's lymph, or tuberculine, were greater than the ability of any visitor to take them all in. The hours were so arranged that you could spend nearly the entire day at the various clinical demonstrations. I was fortunate enough to get to Berlin after the great rush was over, and did not experience the disadvantages of crowded clinics. If I should have been among the first to visit Berlin, I expect I should have gone there like many others, full of hope of the impossibilities, and, like them, returned home discouraged and disappointed. But, as I did not go until the latter part of December, I had had time for sober, second thoughts, and, on my journey, I was constantly meeting or hearing the returned, giving their varied experiences. Some few were hopeful, but the majority were a little disappointed or skeptical, so that, when I arrived in Berlin, I might say that I was neither prejudiced for or against the treatment.

One of the first things I did was to find out just what Koch claimed for his lymph, and not what the public were claiming for it. I think some of our journals and members of our profession have failed to make this all-important distinction. I know by this date that most, if not all, of the readers of this journal have read Koch's statements, but it will be necessary to restate them here if we expect to systematically discuss and present this subject for their consideration:

> In what way this process occurs cannot, as yet, be said with certainty, as the necessary histological investigations are not complete. But so much is certain that there is no question of a destruction of the tubercle bacilli in the tissues, but only that the tissue inclosing the tubercle bacilli is affected by the remedy. Beyond this there is, as is shown by the visible swelling and redness, considerable disturbance of the circulation, and, evidently, in connection therewith, deeply-seated changes in its nutrition which cause the tissue to die off more or less quickly and deeply, according to the extent of the action of the remedy.
>
> To recapitulate, the remedy does not kill the tubercle bacilli, but the tuberculous tissue ; and this gives us clearly and definitely the limit that bounds the action of the remedy. It can only influence living tuberculous tissue ; it has no effect on dead tissue, as, for instance, necrotic cheesy masses, necrotic bones, etc.; nor has it any effect on tissue made necrotic by the remedy itself. In such masses of dead tissue living tubercle bacilli may possibly still be present, and are either thrown off with the necrosed tissue or may possibly enter the neighbouring still-living tissue under certain circumstances. If the therapeutic activity of the remedy is to be rendered as fruitful as possible, this peculiarity in its mode of action must be carefully observed. In the first instance, the living tuberculous tissue must be caused to undergo necrosis, and then everything must be done to remove the dead tissue as soon as possible, as, for instance, by surgical interference. Where this is not possible, and the organism can only help itself in throwing off the tissue slowly, the endangered living tissue must be protected from fresh incursions of the parasites by continuous application of the remedy.

No one who has observed the use of the lymph in a large number of cases can deny that its power to bring about this necrosis is certain and about invariable. The few possible failures merely prove the rule. But as to the last of the above statement, viz.: "The endangered living tissue must be protected from fresh incursions of the parasites by continuous application of the remedy." This seems to be the first rub with some of the opponents of the lymph. These opponents claim that the uninvaded tissues of the body are not protected by the continuous use of the lymph, and that this necrosis of living tuberculous tissue exposes the individual to the dangers of septic poisoning, accompanied by fresh invasion of the absorbed bacilli. To take a decided or emphatic stand for or against this view of the subject, when the use of the lymph is but a few months old, is, to say the least, a little premature. But, if we have to decide now, I claim that the weight of testimony is against the opponents of the lymph. Let us go to the crucial test of results, and see upon which side is reason.

As the honored and distinguished Virchow seems to be the head and front of the opposition, and, as his position upon the subject has had more effect upon the opinions upon the use of the lymph than any other man, let us examine some of his statements, and see if they are as fair and just as we had a right to expect from one so honored and reverenced by medical men of all nationalities. I quote from the *London Lancet* of March 17, 1891:

> Limiting his remarks to facts determined by anatomical investigation, Professor Virchow said that, from the time at which the practice commenced until the end of December, he had examined *post mortem* twenty-one cases in which, during life, injections of Koch's fluid had been practiced, and to these might be added some six or seven more examined during the present year. (A large number also have been examined by his assistants in other hospitals, and elsewhere, and had yielded important facts.)
>
> There is an obvious difference between those cases in which the changes taking place in superficial parts can be observed clinically, and those where the internal organs are affected to an extent difficult to estimate by the most careful clinical investigation; and it is of interest to contrast the latter with the former. Of the twenty-one cases referred to, sixteen were cases of phthisis in the limited sense, *i. e.*, in which the lungs were especially involved. The remaining five cases comprised: *First*, a well-marked case of tuberculosis of bones and joints; *second*, a case presenting the rare concurrence of cancer of the pancreas with small, smooth-walled cavities in lung and apical induration; *third*, an empyema in a puerperal case, which would probably have proved fatal apart from the injections; *fourth*, pernicious anæmia, with very limited old lesions in lungs, and tuberculous pleurisy, and, *fifth*, a case of arachnitis tuberculosa. In the remaining sixteen, strictly pulmonary cases, all showed more or less extensive phthisical ulceration.

Reserving for another opportunity a detailed statement of these cases, Professor Virchow proceeded to make some general remarks on the experience derived from them. Just as observation of external parts had shown that the remedy acts as a severe irritant, exciting redness and swelling, so the same effects had been well seen in the internal parts. He showed a preparation from a case of arachnitis tuberculosa in Henoch's clinic, in which there were also some old caseo-pneumonic areas in the lungs (the probable focus of the meningeal metastasis), together with recent inflammatory changes. After four injections, amounting in all to two milligrams, the last being sixteen hours before death, the patient (a boy two years and a half old) died. Professor Virchow did not remember ever having seen so "colossal" a hyperæmia of the pia mater, and even of the brain itself. The pia matral vessels were extremely distended, and the brain tissue of a dull reddish tint. In this, the only case of the kind in the series, he personally examined the tubercles in the arachnoid, but could detect no degenerative changes in them; they were well formed and of the ordinary character. Similar conditions of acute hyperæmia and swelling were also to be found in other internal organs. They had often noted an unusual deep injection of the granulation layers of old pulmonary cavities; sometimes a hæmorrhagic infiltration of the walls, or evidence of recent hæmorrhage into the cavity. In a man, thirty years of age, with an old rectal fistula and numerous tubercular ulcers in the colon, death followed upon hæmoptysis from an old ulcerating focus; he had been injected seven times, the last occasion when the hæmorrhage set in, being thirteen days before his death. But these visible changes were not confined to such marked hyperæmic swellings which obviously might be very transient, for there was not the least doubt that *actual inflammation*, with *active proliferation*, occurred to a considerable extent. This is well shown at the margins of ulcers and in the neighbouring lymphatic glands, especially the bronchial and mesenteric. The glands were most markedly swollen, that form of medullary swelling peculiar to acute irritation, and due to a rapid proliferation of the cells within the gland. This change is often associated with obvious leucocytosis, which may be assisted by the infiltration of white blood corpuscles around the tubercle. Sometimes these inflammatory swellings are dangerous. Thus in the larynx, although the ulcers may become healthier, the neighbouring tissue enormously swells, and may produce a critical degree of stenosis. Sometimes the change may assume a phlegmonous type, comparable to what is seen in œdema of the glottis and retro-pharyngeal abscess, as illustrated in a case seen this month (January). No doubt it is difficult to assert that any such inflammation is due to the injections, for there is no criterion for any differentiation; nor was he prepared to say precisely how this kind of inflammation may be recognized and distinguished from other inflammatory lesions arising in the course of phthisis. But in the lungs certainly there are lesions which are exceptionally peculiar.

Among the fatal cases of ulcerative phthisis the great majority showed widespread changes of recent date, mostly in the lungs, but also associated with pleurisy of a very severe type, simple and tubercular, hæmorrhagic and not rarely bilateral. The lung changes may be separated into two seemingly very different categories. The one corresponds to what is styled "caseous pneumonia," or anatomically, "caseous hepatization." It might be thought very doubtful whether this change was in any way connected with the injections. Professor Virchow would himself have doubted this were it not that some of the cases showed it in a special degree, and he exhibited a portion of lung which had undergone caseous hepatization to an extent the like of which he had not seen for years. The lungs were large, their lower lobes, especially the right, as voluminous as in ordinary hepatization; but the foci were so thickly massed as to leave hardly any parenchyma between them. It was like a piece of black sausage richly laden with fat. The non-caseous parts were blackish and sharply demarcated from the caseous. The man was thirty-three years old; he had had six injections, the last four weeks before death, and the injections were suspended because of supervention of continued fever and infiltration of the lower lobes. This infiltration started just after the injections, for previously there were only signs of induration at one apex, where was afterwards found an old indurated focus. In other cases, also, the condition of the lungs similarly differed from what is usually seen in phthisis; in five of the cases there were more or less large masses of caseous hepatization, but not approaching the extent of the case related.

They had lately a very remarkable case of a boy, three years of age, with tuberculosis of the vertebræ and long bones, and where large tubercles were found in the brain. The injections had reached 0.012 gr. It was a surgical case, in which spinal caries with psoas abscess and much disease of the joints and bones of the lower limbs existed. At the necropsy there were as many as seven so-called "solitary tubercles"—*i. e.*, large caseous masses—in the brain and cerebellum; but neither in them nor in their vicinity were any marked changes to be seen. There were a few spots of softening, but not of special import, and certainly none of the nodules showed any marked destruction."

I wish I had space to quote the entire article, that I might not be accused of doing the distinguished author a seeming injustice, by selecting just such portions of it as suited my point, but if you will read it in *The Lancet* you will see that there has been no injustice done or advantage taken.

"It is imperative that the question should be fairly faced and impartially handled; otherwise there may be witnessed as great a revulsion against the use of the 'remedy' as there has been of indiscriminate enthusiasm at its first adoption." In the first place Virchow claimed twenty-one *post-mortems* for himself, and a large number for his assistants in other hospitals and elsewhere. At first glance this looks rather serious for some five or six weeks' use of the lymph. But let us examine or review the conditions of these cases and see if they are such cases as Koch said his lymph should be used in. Five of the cases Virchow eliminates himself after he has first accredited them to the use of the lymph, so we will only have the remaining sixteen. In these sixteen cases we have one boy, two years and a half old, with tubercular arachnitis, with some old caseo-pneumonic areas. One man, aged thirty, with old rectal fistula and numerous tubercular ulcers in colon. Five cases of more or less large masses of caseous hepatization. One boy, three years of age, with tuberculosis of the vertebræ and long bones, large tubercles in brain and psoas abscess. We are not told the condition of the remaining eight cases, but, if they were such as the ones described above, they were sorry cases indeed, and not one of them a fit subject for the lymph. The mighty have fallen very low when the great Virchow can stoop to make the use he did of such material. I take the following from the pen of Dr. O. Isreal (*London Lancet*, December 6, 1890), who was selected by Virchow to examine some specimens from patients operated upon after being treated with Koch's lymph. "It has been proved by Baumgarten that, in cases of progressive tubercular disease, the mere appearance of bacilli in the tissues of a certain part does not immediately induce proliferation of the tissues, which subsequently end in necrosis. On the contrary, a certain, though limited, multiplication of the bacilli *in loco* is a necessary condition for the occurrence of such necrosis." Now test by this fact, many of the conditions pointed out by Virchow as being probably due to the use of the lymph. Virchow says he performed twenty-seven *post-mortems*, and a large number by his assistants. A large number is a very indefinite term, but we will say that it means half as many, or ten, and we have a total of thirty-seven. In the *British Medi-*

cal Journal of March 14, 1891, you will find the following excellent tabulated report of all the cases receiving Koch's lymph, in the University clinics and "polikliniks" and other public institutions of Prussia. (This tabulated report was made up from the report made by the order of Von Gossler, the Prussian minister of education. It only includes the cases treated in November and December).

TABLE I.—*Statistical Statement of the Action of Koch's Fluid in Tuberculosis of Internal Organs.*

DISEASES.	Number of Cases Treated.	Cured.	Substantially Improved.	Improved.	Unimproved.	Died.
I.—Pulmonary Tuberculosis:						
1. Early pulmonary phthisis........	242	9	72	59	93	0
(*a*) With laryngeal tuberculosis.	30	0	10	6	13	0
(*b*) With tuberculosis of other internal organs.........	7	0	1	2	4	0
(*c*) With other diseases........	8	0	0	1	6	0
2. Moderately advanced pulmonary phthisis	444	1	68	68	278	6
(*a*) With laryngeal tuberculosis.	85	1	10	11	37	2
(*b*) With tuberculosis of other internal organs.........	15	0	1	4	5	2
(*c*) With other diseases.........	14	0	0	0	7	2
3. Very advanced pulmonary phthisis (cavities)	246	0	7	31	162	30
(*a*) With laryngeal tuberculosis.	60	0	1	4	45	5
(*b*) With tuberculosis of other internal organs..... ...	24	0	1	2	17	1
(*c*) With other diseases.	16	0	0	1	7	5
I.—Pulmonary Tuberculosis (all grades taken together).. ...	932	10	147	158	533	36
(*a*) With laryngeal tuberculosis.	175	1	21	21	95	7
(*b*) With tuberculosis of other internal organs.........	46	0	3	8	26	3
(*c*) With other diseases..........	38	0	0	2	20	7
II.—Laryngeal Tuberculosis.......	63	1	18	23	15	4
With pulmonary tuberculosis.	45	0	16	13	12	4
III.—Pleurisy	13	1	0	3	9	0
IV.—Pernicious Anæmia.............	1	0	0	0	0	1
V.—Tuberculous Meningitis........	4	0	0	1	1	2
VI.—Peritoneal Tuberculosis.......	14	1	3	3	4	2
VII.—Intestinal Tuberculosis.......	1	0	1	0	0	0
VIII.—Renal Tuberculosis............	4	0	0	0	4	0
IX.—Urethral and Vesical Tuberculosis	10	0	0	4	5	1
X.—Testicular Tuberculosis.......	18	0	2	2	14	0
XI.—Double Tuberculous Pyosalpinx, with incipient pulmonary phthisis.	1	0	0	0	1	0
Totals...	1061*	13	171	194	586	46

* The difference between the total number of cases and the number in which the result of treatment is given is due to the fact that a few reporters give no information as to the result.

Table II.—*Statistical Statement of the Action in Koch's Fluid in External Tuberculosis.*

DISEASES.	Number of Cases Treated.	Cured.	Substantially Improved.	Improved.	Unimproved.	Died.
I.—Lupus	188	5	78	84	21	0
With tuberculosis of internal organs	27	0	5	6	3	0
II.—Tuberculosis of Single Bones and Joints	397	9	51	119	211	6
With tuberculosis of internal organs	48	0	1	4	22	1
III.—Tuberculosis of Several Bones and Joints	40	0	3	12	23	2
With Tuberculosis of internal organs	10	0	0	1	7	2
IV.—Tuberculosis of Lymph Glands.	38	0	9	7	22	0
With tuberculosis of internal organs	8	0	1	0	7	0
V.—Tuberculosis of Soft Parts	8	0	1	4	3	0
VI.—Tuberculosis of Scars	4	0	0	3	1	0
VII.—Scrofuloderma	6	1	2	3	0	0
VIII.—Lepra	2	0	0	1	1	0
IX.—Rodent Ulcer	2	0	0	1	1	0
X.—Tuberculous Anal Fistula	3	0	1	0	1	1
XI.—Tuberculosis of Sheaths of Tendons	1	0	1	0	0	0
XII.—Scrofulous Eczema	1	0	0	1	0	0
XIII.—Scrofulous Keratitis of Both Eyes	2	0	2	0	0	0
XIV.—Ear Diseases	16	0	0	2	14	0
With pulmonary tuberculosis.	7	0	0	1	6	0
Totals	708	15	148	237	298	9

We see from this that, out of a total of nearly eighteen hundred cases of good and bad, we have only fifty-five deaths. It seems a remarkable fact that Virchow and his assistants should have performed over one-half the *post-mortems* of all the cases occurring in the entire Prussian kingdom. If this were in politics, instead of "poliklinicks," some one would have to rise to an explanation.

There are many valuable lessons to be learned from the above tabulated report. The scientific world cannot look upon it and say that Koch's "tuberculine" is not a great boon, and a great triumph in the sciences of the nineteenth century. We must remember that this report covers the first cases treated, which, of necessity, must be the most unfavorable. While in Berlin I saw some such cases that died, but they were in the very last stages of consumption, and I have seen here at home many such cases die just as soon without the lymph, and under the best of the old treatment.

We should also remember that the climate of Germany at any season of the year is not favorable to the treatment of tuberculosis, and in the winter season, the time of these experiments, it is probably one of the most unsuitable of all climates. Furthermore, we all know that Germany has just experienced an extraordinarily severe winter. Nearly all, if not all, of these cases come from the poor classes and such, too, as are found in the large cities. While the hygienic regulations of the Prussian kingdom impressed me as being possibly as good as, if not better than, those of any other country, yet the foodstuffs of the poorer classes is not, I think, of such variety and quality as to enable them to resist the ravages of such a disease as tuberculosis. Unless compelled by circumstances, what physician would ever think of treating, or selecting such circumstances under which to treat, tuberculosis ? Have not the fatal experiences of the past taught us and our patients, if possible, to flee from such surroundings ? In an unfavorable climate, in the midst of a severe winter, with a poor class of patients, many of them suffering from a complication of diseases, and located in large hospitals and in crowded cities, the "lymph" has accomplished results which should fill us with hope and faith in its final triumph. It may do us good just here to consider for a moment our condition before the discovery of the lymph. I will give it in the words of Dr. T. W. Hime, of England :

"The magnitude of the evils arising from the prevalence of tuberculosis was greatly increased by the terribly long duration of the disease, which caused its economic importance to be so much greater than that of almost any other disease, and by the fact that adults, the most effective portion of the population, suffered so largely. It was cruel enough to see young children swept off rapidly by measles, whooping-cough and other diseases, but it was far worse to see their parents and adult brothers and sisters slowly gnawed away by the relentless bacillus of tuberculosis. The modern discovery that the tuberculous patient is a source of infection to those around him, during the long, weary years of his wasting disease, certainly has not robbed it of any of its terrors, although the discovery, no doubt, will ultimately lead to precautionary measures and protection for those exposed to the risk. Up to the present time it must be admitted that practically we had been helpless against tuberculosis. Medical science had devised little more than uncertain methods of giving general tone and vigor to the tissues of the patient by good food, air, tonics, exercise, etc., so as to assist it in resisting the inroads of the organism of the disease. It is unnecessary to particularize the extent of the success attained. But certainly no scientific method of contending against the disease had been even plausibly suggested until the present. Indeed, only a few years ago a distinguished authority gave a reason for the theoretical impossibility of devising a 'protective' against tuberculosis—viz., the fact that one outbreak of tubercular disease does not protect against a second or further one. Suddenly, it may be said, all theories and opinions on this subject have been subjected to a rude shock, and in a most unexpected manner. The excitement and enthusiasm aroused by the announcement that Koch had discovered a successful method of dealing with tuberculosis have surpassed all similar occurrences. Within a few days of the announcement of the discovery thousands of medical men, including many of the most distinguished in every land, had abandoned their professorial and private work, and in the depth of winter were pilgrimaging to Berlin to see with their own eyes the new method in operation, and with a vague hope of bringing back some of the liquid for use at home."

The opponents of the lymph talk of dangers, bad results and death from the use of the lymph. Does the tabulated statement of the first two months tell a story of danger, bad results and death? But what is the story of tuberculosis without the lymph? Could any story be more pregnant with dangers, bad results, to finally end in death? Twenty-eight cures, 319 substantial improvements, 431 improvements, or a total of 778 cured or improved, out of 1,769 cases. Or, in the city of Berlin, 36 cured, 306 more or less improved, or a total of 342 cured or improved, out of 623 cases. Is this a story of dangers, bad results and death ? To fully appreciate these results, we must not for a moment forget that the large majority of these cases were not such as Koch claimed would be benefited by his lymph. It was all right and proper that these cases should have been treated, and the results reported, but, in making up our verdict, let us give them their proper value. Let us again refer to the statement of Koch, viz.: "These experiences lead me to *suppose* that *phthisis in the beginning can be cured with certainty by this remedy.*" What are the results of the first two months of treatment of 242 cases of early pulmonary tuberculosis ? Nine cures, 72 substantially improved, 59 improved, 93 unimproved. You may say that there is small encouragement in only nine cures. But remember this is only after two months' treatment. Who can say how many of the 72 or 59 may not be transferred to the cured list, after longer treatment, and especially if they could be placed under more favorable climate and hygienic influences, and, last, but not least, when we have learned how to use the lymph. As our knowledge of diseases enlarges and becomes more detailed and accurate, our ideas of the stages of diseases are constantly changing. Have we not come to regard all of our infectious or contagious diseases as having a stage of incubation ? If I mistake not, these incubating stages are not characterized by any appreciable anatomical or structural lesion, and frequently with little or no constitutional disturbance. May this not be true of tuberculosis? You may say, that, if this be true, the lymph will only act upon tuberculous material, the presence of which indicates that the disease is beyond the stage of incubation. Theoretically and anatomically, this is true, but, practically, it is not so. That is a hard saying, and hard to believe, but let us see. Many men and women are going about their daily work with a deposit of tubercle in their lungs, and they have never suspected it. They eat well, they sleep well, and work well, and all the functions of the body work well. Let me illustrate the point by a case which occurred at the Victoria Hospital for Consumptives, London, England.

One day, while visiting this hospital, Dr. Heron, who is one of the leading practitioners of London, and who has charge of this hospital, showed me a young woman whose case had been a little amusing, as well as very valuable in showing the diagnostic value of the lymph. Dr. Heron said he had selected this case to show that the lymph in a certain dose would have no effect upon a perfectly healthy patient. I think this patient had not only been examined by Dr. Heron, but by several others, and she gave not the slightest evidence of phthisis, nor could she give any family history of phthisis, and she had been healthy and strong all her life. A few hours after the injection, this patient had a strong reaction, and the local reaction in the lung revealed the spot. Under a few weeks' use of the lymph this patient made a perfect recovery, and looked to me to be in perfect health, and she stated that she never felt better in her life.

Such a case as this may be considered rare, but let us take another case that is not rare. A patient comes to you and he gives you a history of his case, and you suspect tubercle, but he tells you that, up to a short time ago, he was in perfect health; never had to consult a doctor before, and tells you the amount of work he could do, and what he could stand. You examine his lungs, and you find they are all right, as far as you can judge, and you relieve his mind and apprehensions by telling him there is nothing the matter with his lungs, but to be careful, and you give him a tonic, and he gets better. It is not long before he comes back, and the same examination and opinion and advice are given him as before; but, after a varied length of time, you discover what we call the signs of incipient phthisis, and, if he is in good circumstances, or can afford it, we advise him to go to some climate like Florida, or our western slope. He does so, and in a few short years, as a rule, he returns, that his bones may have a resting place among his kindred at home. I believe these patients suffer from, or present, incipient phthisis some time before the most skilled diagnostician can detect it. I believe, by the use of the microscope and the lymph, we shall be able to make a diagnosis in time to save most of these cases. In some future issue of this journal I may make some suggestions as to the therapeutical applications of the lymph.

Let me close this lengthy article by saying that I believe we have ever reason to be encouraged in regard to the final success of the lymph. We should congratulate ourselves and suffering humanity that Koch says that he is not through with it, and is still working upon it. I take great encouragement from Koch's attitude during the test of his lymph. He gave it into the hands of friends and foes alike, and, although in the past half year, he has passed through an experience that has been the most remarkable of any living man, yet he has continually borne himself with a quiet placid dignity that is born only of the consciousness of final triumph. As a fitting close to this article let me insert the following from *The London Lancet* of January 10, 1891 :

> Koch came to my institute on April 30, and I can truly boast that in the first hour of our intercourse I recognized in him an unequaled master of scientific investigation ; his method, proceeding with rigid consistency from step to step, the elegance and certainty of his experiments, the classic clearness of his statements, were all as perfect in his first, then just completed, work on anthrax as in all his later researches. For Koch's works are distinguished from those of most investigators by the circumstance that he does not publish them till they are finished to the last point. Others cart up stones to be used in the building up of science, or draw a new plan or add a new wing, a new story, a new roof, but they finish only the brickwork, and leave it to others to complete the building and make it habitable. Koch, on the other hand, does not let his scientific fabrics leave his hands till he has made them completely fit in all their details as well as in the main for the use of others, who have then nothing more to do than to add this or the other little furnishing. All Koch's works have been so complete in form and contents that nothing remained for those that followed but to confirm them, for it was not possible to add anything essential. Such were the first works of 1875 on anthrax, that, on wound infection, the numerous treatises in the communications of the Imperial Office of Health, the magnificent researches on the tubercle and cholera bacilli, and such beyond doubt his latest discovery will prove.

OBSERVATION ON COUNTRY SURGERY.

BY PROF. A. W. MCALESTER, M. D.

Can aseptic and antiseptic surgery be practiced outside of well regulated hospitals, especially in small towns and country places? I answer, yes. Since we understand the science of aseptic and antiseptic surgery, the advantage is decidedly in favor of country air. There are fewer pathogenic bacteria in a sparsely inhabited region than in a dense city; fewer persons to furnish effete material.

There is an inherent power to resist disease. The human system might throw off a few pathogenic bacteria but would succumb to larger numbers. The country physician has really less use for antiseptics. Aseptic surgery is much more desirable than antiseptic surgery, for the reason that the antiseptics irritate cells. The less a cell can be irritated the quicker it can repair the injured tissues. Hence asepsis is decidedly preferable from a scientific point of view, and, from a practical standpoint, much easier applied. Really less skill upon the part of the practitioner is required. The keynote of asepsis is "heat." Everything that comes in contact with your patient must be heated.

To prepare the room: —

The furniture should be removed, the carpet taken up, the floor scrubbed, the windows washed with hot water and dried with heated air, as hot as possible. The hotter the air the better, as heat modifies all pathogenic germs. Use plain furniture because it can be more thoroughly cleaned. See that every article of clothing has been subjected to at least 212° moist or dry heat.

Now for the day of operation: —

See that your patient has a hot bath and no clothes on but clean underclothing. See that yourself and attendants are cleaned. (Use a nailbrush.) Render every instrument aseptic by hot water, and either roll them in aseptic cloths or put in an aseptic dish. Cool all water used, in a tightly covered vessel; never cool by pouring cold water into your vessel. It had as well never boiled, as a "little leaven leaveneth the lump." Drainage tubes are hard to render aseptic.

Give the wound a final washing ; close it, and sprinkle the edges with iodoform or its equivalent, then cover with either aseptic rubber tissue or cloth, and cover well with sterilized absorbent cotton. I gathered this use of cotton from Dr. P. Paquin, who kept some broth eighteen months in a flask using only sterilized cotton for a stopper. The "soup" was as good at the end of eighteen months as it was the day it was put there. The air could pass through the cotton, but no putrefaction, thus showing that the cotton filtered out the putrefying germs. If it will do its work in a flask why not on the human subject? The maxim is, no bacteria, no decay.

Now for the second dressing :—

So long as there is no fever or odor do not redress till the day comes for removing the stitches. Then again have everything rendered aseptic that touches the wound. As a rule antiseptics will be used now on account of their greater convenience in being applied. There is less objection now to antiseptics as you have a skin covering, and your bichloride of mercury will not irritate the cells of the part so much.

Pyoktanine seems to be coming into use of late, because it does not provoke irritation, and is a true germicide. The stains left upon the surgeon's fingers are often objectionable, but alcohol will remove it, if applied before washing.

Where is there a man who cannot be clean? If aseptic, he can dress any wound ; if not aseptic, soak everything used in an antiseptic.

SELECTIONS.

THE FILTRATION OF WATER.—(Concluded.)

BY M. E. DUCLAUX,
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It is evident that, with this constitution, a sand filter is something very fragile, and it is clear, also, that it cannot prevent the passage of a few microbes with the water. The filter cannot, therefore, be perfect. We can reduce greatly the number of bacteria in the filtered water by slackening the speed of filtration ; but then the filter works no longer in the industrial conditions. We may reduce the figure also, as much more as the water is less impure ; but the number given above, concerning Zurich, shows that, even with the relatively pure waters of the lake, the ratio of bacteria in the filtered water never falls to 0. Consequently, bacteria are constantly dragged out of the filter, and, when we reflect, we see that it could not be different.

The sand filter is then a bad instrument, out of which engineers have learned to draw the best possible results. This manner of representing very costly installations has met first with opposition. Under the pretext that it was about an indifferent matter to allow to the filtered water very rich or very poor in bacteria, and that the water drawn therefrom contains always about the same number, we had reached the point of considering a sand filter as formed some way of two superposed systems ; a perfect filter, allowing the passage of scarcely any microbes, formed chiefly by the superior layers, and the nutritive media, formed chiefly by the inferior layers, where the multiplication of microbes takes place, as it occurs in conduit and distributing water pipes.

This conception had the incontestable advantage, in the filtration and multiplication of microbes, of regarding the processes as two different phenomena, and to consider afterwards the germs found in the filtered water as independent of those met with in the water before filtration ; *i. e.*, in a word, to quiet the mind on the use of an apparatus which replaced the dangerous microbic species of alimentary water by common species. But the argument on which rested this conception was scarcely tenable. When a paper filter is perforated or weakened, in one or several points, the proportion of matter in suspension in the water passing through is not necessarily in proportion to the quantity in the water poured therein. This is what we often have occasion to observe in filtering, for instance, a liquid in which sulphate of baryta has been precipitated. The water of a Zurich filter may, likewise, carry the same quantity of germs that the water of a Spree filter may, without proving that the germs are from another source than the filtration water.

Another argument in favor of the same conception of the filter was, that the microbic species of the filtered water are not the same as those in the water of filtration ; they are, in general, much less numerous. But this proves that there is cultivation in the filter, and that the species which it suits best develop the better ; it does not argue that there cannot be a simultaneous dragging of a few of the microbes by the water.

This is, by the way, the recent experimental conclusion of Mr. C. Fraenkel. In filtering through a ripe filter water loaded with a particular microbe easily recognized, the *bacillus violaceus,* he has observed colonies of this organism in filtered water. This experiment is the more probable that, to avoid the possible objection of gradual successive invasion of the filter by the bacilli, multiplying by the means of organic matters carried into the water by the culture media broths diluted therein, Mr. Fraenkel had taken the precaution to make this culture in a media originally very diluted, the mixture of which with the water augmented its nutritive matter only in infinitesimal proportion. But then, if these microbes of the water penetrate the whole thickness of the filter, the question arises, why do they not develop themselves equally throughout the height or body? It is not the organic matter that is wanting. We have seen that, in the Zurich water, judging from the amount of oxygen which it borrows from the hypermanganate of potash, its variation from top to bottom is very slight, and that there was left in the filtered water more than three-fourths of the quantity contained at its entry into the filter. It is true that oxygen disappears more rapidly, but all microbes do not need it, and on the other hand there remain some at the bottom. For instance, in water filtered through a ripe industrial filter we find about half the quantity contained therein before filtration. Why, then, does not the filter become more impregnated in all its thickness, and why is life much more abundant in the superior layers?

This question is important, because if we solve it, we have a chance to find in the solution some light on the subject of this second question of the same nature : Why is it that, in the soil, microbes are in preference on the surface, and gradually diminish as we proceed deeper, until at a slight depth we find layers absolutely sterile?

We see immediately that life is more abundant in the superior layers because there exists more oxygen and more organic matter, and, from the moment that the filter begins to ripen, because of the greater renewing of germs. We see, on the other hand, that a layer so lively on the surface can only render life more miserable in the interior. It is the fate of all microbes to spoil their media of culture for themselves and [sometimes*] others, either in depositing detrimental substances acting in the manner of antiseptics, or in arresting therein useful matters.

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[THE END.]

BACTERIA—A PRACTICAL STUDY IN BIOLOGY.

BY V. A. LATHAM, F. R. M. S., F. S. S., ETC.

DEFINITION.

Biology is the science of living things :—*βιος*—life, *λογος*, science. It may be divided into two branches, each of which corresponds to a distinctive mark of living things. They may be recognized, *first*, by their form—morphology ; *second*, by their effects (movements and mutual actions, chemical), physiology. The simplest possible organism is *torula*, the single cell of *saccharomyces*, or yeast. There is no well-defined limit between ferments and fungi, or, again, between fungi and bacteria. Their smaller size is the principal difference which separates bacteria from ferments, since in other respects these two classes are for the most part alike in form and organization. Everyone now speaks of microbes, yet few of those who make use of the term have any clear conception of the organisms in question, or could give an exact account of the function which microbes fulfill in nature. And yet this function concerns us all. There is much to be done before modern society is practically on a level with the achievements of science; many prejudices must be uprooted and many false notions must be replaced by those which are sounder and more just.

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* The translator.

In order to indicate the organisms which produce diseases, the English and Germans use the word *bacteria,* which is only the name of one of the peculiar species assigned to this group, and the one with which we have been longest acquainted. In this case the name is generalized and applied to the entire group. The Italian authors, who have been recently occupied with the study of microbes, have, on their part, adopted the name, *protista,* proposed by Haeckel, and of which the sense, although not the etymology, is almost the same as that of the word, *microbe,* which is the French term for bacteria, and only signifies a small living being. It decides nothing as to the animal or vegetable nature of the organisms in question. Bechamp terms microbes, *microzyma,* or small ferments, since the chemical reactions which result from their vital activity are generally ferments. Bacteria are distinguished from animal cells by being able to derive their nitrogen from ammonia compounds, and they differ from the higher vegetable cells in being unable to split up carbonic acid into its elements, owing to the absence of chlorophyl.

The *schizomycetes,* or "splitting-fungi"—German, *spaltpilze* (σχιζω, I split; μυκος, fungus)—are unicellular plants, which multiply by repeated subdivisions in one, two or three dimensions of space, and also frequently reproduce themselves by spores, which are formed endogenously. They live either isolated or combined in various ways, in fluids and in living or dead organisms, in which they produce decompositions and fermentations, but never alcoholic fermentation.

I shall use here the method I gave in my paper on *amœbæ* in the *American Monthly Microscopical Journal* for July, 1889, which may be altered to suit requirements: (*a*) Structure, (*b*) digestion, (*c*) absorption, (*d*) circulation, (*e*) respiration, (*f*) secretion, (*g*) nervous system, (*h*) sense organs, (*i*) motor organs, (*k*) reproduction, (*l*) development, (*m*) classification.

PRACTICAL WORK.

Every plant or animal must be seen, examined, dissected and drawn.

(*a*) STRUCTURE.

1. *Occurrence.* — Wherever there is putrefaction they are present in vast numbers. In water, in soil, in sewage, in the intestines and in uncleanly persons—especially on the skin and between the teeth—various species may be found. The red color noticed in mouldy bread is due to bacteria. Such diseases as diphtheria, typhus fever, consumption, cholera, anthrax (or "wool-sorters' disease"), appear to depend on their presence.

Many cases of fermentation are due to the presence of these organisms, and the putrefaction of plants and animals seems to result from fermentations originated by them. Students who may wish to prepare these organisms without the help of disease will find it best to infuse hay in warm water for thirty minutes; filter, and keep the filtrate in a warm place. Note the changes which go on in it. At first, clear; in twenty-four to thirty-six hours, it becomes turbid; later on, a scum forms on the surface, and the infusion acquires a putrefactive odor. One very common bacterium may be easily procured,—*bacterium termo,* Dujardin ("zoophyt," p. 212); (synonyms, *monas termo,* Mueller; (?) *palmella infusionum,* Ehrenberg; *zooglœa termo,* by Cohn)—by taking half-a-glass of ordinary water from a spring or river, and leaving it for some days on a table, or chimney-piece, the vessel being uncovered to allow free access of air. The water from the top of a small aquarium will also show them, or a small piece of meat kept in water at a moderate temperature.

2. *Size.*—They are very minute. Hence arises a great danger of the confusion of other bodies with these on the

part of the student. The cells are shortly cylindrical, oblong, about 1.5 to 2μ long, with a flagellum at each end.

3. *General structure.*—They are masses of protoplasm of various shapes, that are, in many cases, not surrounded by a distinct wall. Protoplasm is derived from πρωτος, first; πλασμα, formative matter; *i. e.*, matter that can be shaped into other substances, such as the tissues of a plant or of an animal body. It is semi-fluid, granular in appearance, and consists of four elements—carbon, hydrogen, oxygen and nitrogen. It has the power of contractility. The protoplasm adheres to iodine, and it becomes brown. If the piece of protoplasm is without an enveloping wall, as in many bacteria, and consists of protoplasm, and protoplasm only, we have a *plastid.* If the protoplasm is invested with a distinct wall, that is, wholly distinct of structure, the being is a *cytode;* for a cytode is a free mass of protoplasm, enveloped by a distinct wall. This wall is more transparent than the contents. In the compound form it is only to be seen just where the joints, making up the compound form, come in contact, one with the other. In the still condition of these organisms, the wall is exceedingly gelatinous. This still stage, with its thick envelope of jelly-like material, is known as the *zooglœa* stage (Ζωον, life; γλοιος, viscid).

4. *Different forms* of bacteria are classed under this heading. When they occur alone, they may be either spherical, as in certain forms of micrococcus, or rod-like, as in the true bacteria. When they occur aggregated together, they may be of the form of rudimentary cells, as in other varieties of micrococcus, or as rod-like structures, joined together. Even this last arrangement admits of subdivision, as rod-like parts may be conjoined end on end, or at an angle (not of 180°), or wound in a spiral. The following table may make this clear:

BACTERIA
- Isolated
  - Spherical—*e. g.*, Micrococcus.
  - Rod-like—*e. g.*, Bacterium.
- United
  - Spherical—*e. g.*, Micrococcus.
  - Rod-like
    - Parts joined end on end *e.g.* Bacillus
    - “ “ at an angle—*e. g.* Vibrio
    - “ “ spirally (often a double spiral)—*e. g.*, Spirillum and Spirochæte.

5. *Effects of reagents and temperature:—*

1. Iodine stains all formative matter or protoplasm brown, and occurs with all formative matter, ready to be, but not yet actually, transformed into a plant or animal substance. The outer wall does not stain.

2. Magenta or carmine solution also stains protoplasm.

3. A temperature of 0°C. (32°F.) and of 60°C. (140°F.) kills them. These are their limits of temperature. They thrive best at 30° C. (86° F.).

4. Desiccation: They can survive a lengthy period of drying or desiccation, and on adding moisture they revive.

(*b*) Digestion.—Bacteria feed on decaying organic matter. Hence their name of *saprophytes* (σαπρος—putrid, Φυτον—plant). Pasteur's fluid causes them to thrive. This food is taken in by the whole of the general surface. There is no definite mouth or digestive apparatus.

(*c*) Absorption.—As in many of the lower living beings, the function of absorption is merged with that of digestion. The whole surface of the bacteria absorbs food. But that very absorption is here in reality a digestive process, and results in the in-taking of food.

(*d*) Circulation.—Nothing to be noted.

(*e*) Respiration.—The organs of respiration are on the whole body surface. The lower we descend in our study of biology the more do we find every function performed indifferently by every part. Nothing is specialized. The whole body breathes, reproduces.

(*f*) Secretion.
(*g*) Nervous system.
(*h*) Sense-organs.
} There is nothing to be studied under these heads.

(*i*) Motor organs.—I would here warn the student against a movement noticeable in these organisms that he will be apt to regard as due to life. It is highly important not to confound the two kinds of motion. That of dead matter is merely mechanical, not vital, and resembles somewhat the swinging motion of a pendulum, or that of "a floating buoy round its mooring." This movement can be seen whenever any very small particles of matter, living or dead, are suspended in a liquid. Very finely-divided charcoal, camphor, cinnabar or gamboge, if placed in water, will exhibit similar movements. It is called the *Brownian movement,* after Brown, who thoroughly investigated it. It is simply a molecular movement, due to mechanical, not to vital, causes. Some of the bacteria only show this motion, and are then said to be in the still stage. As in this condition they are usually surrounded by a quantity of jelly-like material, this stage is known as the *zooglœa* stage. Very often these organisms are in an actively mobile condition, and undergo movements of translation from place to place. The cause of these movements is in most cases not known. It is possible they may result from the general contractility of the protoplasm. But, in *spirillum volutans,* at each end a cilium or long, fine, hair-like process has been seen, and by the movement of the cilium that of the spirillum as a whole is effected. *Vibrio* has a wriggling motion, which is really due to its having a zigzag arrangement of its joints, and also a rotation upon its own axis. *Bacillus* is always free-swimming.

(*k*) REPRODUCTION.—This in living things is either asexual or sexual. The former is called *agamogenesis* (*a*—without, *γαμος*—marriage, *γενεσις*—reproduction). The latter, *gamogenesis*. Only the asexual or agamogenetic is known in connection with those low forms of living things. The particular method encountered here is division or, technically, *fission* (findo—I split). Certain divisions of the bacterium undergo transverse division. A cytode is divided into two by an ingrowth of its wall, and the cytodes thus formed last a longer time, and can resist injurious agencies more effectually than their fellows. By such division a bacterium becomes two bacteria. Bacillus also produces spores, *e. g.*, rounded structures that are thrown off from the parent and developed into a new being.

(*l*) DEVELOPMENT.—Nothing can be said here, as the new individual is of the same nature as the parent.

(*m*) CLASSIFICATION.—Cohn classifies the bacteria according to their form into *sphærobacteria* (globular cells), *microbacteria* (minute, rod-like cells, bacteria proper), *desmobacteria* (large rod-like or filiform cells, filobacteria) and *spirobacteria* (twisted or spiral cells). The student should rigidly adhere to order in this. For our convenience we divide everything in the universe as mineral, animal and vegetable.

We regard each kingdom as divided into sub-kingdoms. These, again, contain classes. Each class is made up of orders. An order has genera (genus—kind). A genus consists of species. Hence, in classifying bacteria, we say its food is inorganic; therefore, it belongs to the kingdom *vegetabilia.* It is a flowerless plant, without stamens and carpels ; therefore, it belongs to the sub-kingdom *cryptogamia* (κρυπτος—hidden, γαμος—marriage). There is no distinction of axis and appendages, as in the stem and leaves of a tree ; therefore, it is of the group *thallophyta* (θαλλος—a sprout, φυτον—a plant). It is without green coloring matter, chlorophyl ; therefore, of the class fungi. Gamogenesis, unknown, fission the only form of agamogenesis ; therefore, of the order *schizomycetes* (σχιζω—I split, μυκος—fungus). Genus, *bacterium, vibrio* or *bacillus,* etc.

For the CHEMICAL COMPOSITION of bacteria, we are indebted to Nencki. Their constituents vary slightly according as to whether the bacteria are in zooglœa, or in the active state. In 100 parts of the dried constituents, there are the following :

A nitrogenous body, 84.20 ; fat, 6.04 ; ash, 4.72 ; undetermined substances, 5.04. This nitrogenous body is mycoprotein, so called, and consists of carbon, 52.32 ; hydrogen, 7.55 ; nitrogen, 14.75, but no sulphur or phosphorus. The nitrogenous body appears to vary with the species, for in *bacillus anthracis* a substance has been obtained which does not give the reactions of mycoprotein, and, therefore, is distinguished as anthrax-protein. Bacteria can and do utilize the last traces of energy in urea. It is the bacteria which play the most important part in disease, exciting both general and systemic affections. The others, *e. g., blastomycetes* (yeasts), and *hypho mycetes* (moulds)—exert a merely local influence. The animal parasites become dangerous in virtue of their size, or multitude, or by penetrating into vital organs. Special reagents or staining processes have to be employed to discover them ; sometimes certainty is only reached by experimental cultivation of the products of disintegration of the tissue in question.

REAGENTS.—Water is essential for their growth, though deprivation does not kill all the bacteria. Different species grow best on different nutrient media.

Effect of temperature.—Here again they vary, many grow best at the temperature of the blood, and hence the value of agar-agar media, which is not liquefied at 37° C. (or 98.60 F.). The *B. tuberculosis* will only grow at a temperature varying between 30° C. (86° F.) and 41° C. (109° F.).

Cold.—The bacteria seem to have a special power of resisting cold, even comma bacilli, if exposed to a temperature of —10° for an hour, and bacilli of anthrax after exposure to a temperature —110° C., still retain their vitality. The spores retain their vitality after immersion in boiling water, but are destroyed by prolonged boiling.

Movement prevents their growth.

Gases.—Hydrogen and carbonic acid are believed to stop movement of the motile bacteria. Chloroform is believed to arrest the changes brought about by the zymogenetic species.

Electricity.—Cohn and Mendelssohn found that a constant galvanic current produced a deleterious effect owing to electrolysis.

Light.—Sunlight is fatal to putrefactive bacteria.

Carbonic acid.—A 5-per-cent. will kill the spores of *B. anthracis* in 24 hours. Three per cent. will not do so in the same time. A 1-per-cent. kills the bacilli.

Chloride of zinc in 5 per cent. has no effect on anthrax spores, even when they have lain in it for a month.

Sulphurous acid is not a good disinfectant, and will not penetrate compact masses or bundles.

Corrosive sublimate has the most powerful effect on the organisms, an aqueous solution of 1 : 20,000 kills the spores of bacilli in 10 minutes. A solution of 1 : 5,000 is thus a certain disinfectant.

Iodine, bromine and chlorine are far more active than sulphurous acid. Bacilli cease to grow in iodine of 1 : 5,000, and of bromine of 1 : 1,500.

The oils of thymol, cloves, peppermint, mustard, turpentine, eucalyptus, all restrain their development ; the latter being very good, and is especially useful in dental cases to prevent bacterial growth in the teeth, as it penetrates the tubules. All disinfecting reagents should be used in aqueous solutions.

PRACTICAL WORK.

First.—Observe Brownian movement in gamboge, etc., suspended in water.

Second.—Turbid hay infusion under high power.

Third.—Stain the various organisms.

Fourth.—Stain with magenta.

Fifth.—Observe cilia in *spirillum.*

TO STAIN THE BACTERIA.—The following methods are useful for all bacteria, micrococci, and bacilli, except those of tubercle and leprosy: Dry a film of fluid containing the bacteria on a cover-glass, pour a little staining solution into a watch-glass, and place the cover on it, with the *dried material downwards,* leave for from 5 to 60 minutes. The time can only be learnt by practice, as the materials differ. When thoroughly stained, wash the cover-glass in methylated or rectified spirits until all the superfluous color is removed, taking care that it is not washed *too* much, or the bacteria film washed off. Then dry the cover-glass by holding it on its edge on blotting-paper, allow to dry. Then mount in Canada Balsam.

TO STAIN SECTIONS OF TISSUE CONTAINING BACTERIA.—Place them in the stains given below and leave for some hours. When deeply stained, wash in water to remove excess of stain, then lay them out flat in spirit and leave till no more color comes away. Transfer to absolute alcohol which fixes the color, then to clove oil, and mount in Canada Balsam.

The best stains are Gentian Violet, Spiller's Purple and Methyl Blue, the great difficulty being to obtain good samples of the dye, as the manufacturers change the numbers often, and the anilins differ greatly.

GENTIAN VIOLET (2 per cent.)—Take 2 grms. of the powder, rub it up in a mortar with 10 cc. alcohol (sp. gr., 0.830), some prefer that in which 2 cc. of anilin oil has been dissolved. Then add gradually 99 cc. of distilled water while stirring.

SPILLER'S PURPLE.—Make as above, using the same strength.

METHYL BLUE.—A 2-per cent. solution in distilled water and a little alcohol added whilst triturating the powder, *previ-*

ous to the water being added. (A little Liq. Potassæ, 1 cc., may be added in preference to alcohol if desired.)

GRAM'S method, with a saturated alcoholic solution of gentian violet and anilin water and iodine of potassium, is good.

FOR BACILLI IN SPUTUM AND TISSUE.—The methods are very numerous, but I prefer Gibbes' Double-Stain or his Magenta and Nitric Acid methods, as they are always to be relied on if the dyes are pure and take very little time. I have seen and prepared specimens of sputa in five minutes for diagnostic purposes. The bacilli do not fade.

THE ZIEHL-NEELSEN METHOD and Sulphuric Acid is also very similar to the above Magenta, but I think the Magenta is to be preferred. All the other methods can be found in the various journals and tried by those who wish to experiment; but the two stains given are all that are required by the student and busy practitioner.—*The Journal of Microscopy and Natural Science.*

FISTULA IN ANO IN PHTHISIS.

BY HENEAGE GIBBES, M. D.
Professor of Pathology in the University of Michigan.

Anal fistulæ are common in phthisical patients, and it was formerly thought that they exercised some protecting influence against this disease. The belief was common among practitioners that a patient with suppurating rectal fistulæ was, if not altogether prevented from acquiring the disease, at any rate when suffering from phthisis, enabled to resist the advance of the disease as long as the fistula remained open. Experience has, however, taught us that getting rid of a suppurating cavity is decidedly beneficial to the patient.

I wish to point out what seems to me to be a possible cause of fistula occurring in cases of phthisis. * * *

This sinus is about one-eighth of an inch in depth, it widens out at the bottom, and in the anterior wall, there is a lymph follicle, which is in close contact with the epidermis.

Directly under the epithelium of the anterior wall, and in the angle formed by the epidermis as it passes in towards the mucous membrane of the rectum, is the internal sphincter.

The structure of the parts then is this, between the external and striped muscle and the internal non-striped muscle sphincters there is a deep sinus having at the bottom in the anterior well a mass of lymphoid tissue.

This resembles an ordinary solitary gland, the central portion is composed of dense adenoid tissue, and is partially separated from the surrounding diffuse adenoid tissue by a lymph sinus, the walls of this sinus being formed of a fenestrated nucleated membrane. It resembles a tonsil in structure and arrangement.

It is now a well-known fact from experimental investigation that the tissues first affected after inoculation with phthisical material are those of the disseminated lymphoid follicles in the lungs, spleen and other parts; it is, therefore, perfectly justifiable to conclude that in a case of general tuberculosis this lymph follicle at the bottom of this sinus may become the seat of tubercular change followed by breaking down and subsequent ulceration. This ulcerative process would have to extend only a short distance internally to involve a so-called sweat gland, the duct of which passes upwards through the anterior fibres of the internal sphincter; and there opens on the surface. In this way there is direct communication with the mucous membrane about half an inch or less inside the external sphincter. It must be remembered, however, that on the introduction of the finger or a speculum the sinus before mentioned would be spread out and obliterated, and this will account for the statement made by many surgeons, that the internal opening is found much higher up. The same fact will account for the statement that the internal sphincter embraces the lower one and one-half inches of the rectum, as a matter of fact which can be verified by an examination of a section through the parts. Quain's description is perfectly correct, namely, that the internal sphincter embraces about the lower half inch of the rectum.

Some cases of fistula *in ano* are described in which the external opening exists outside the external sphincter. These cases may be accounted for by the ulceration extending outward until it reaches the body of some of the numerous glands which lie outside the external sphincter, with their duct leading directly to the surface.

In this way a fistula may be formed, with its internal opening within an inch inside the anus, and having the external opening either at the bottom of the sinus, or, if the ulceration has extended further, it may be outside the external sphincter.

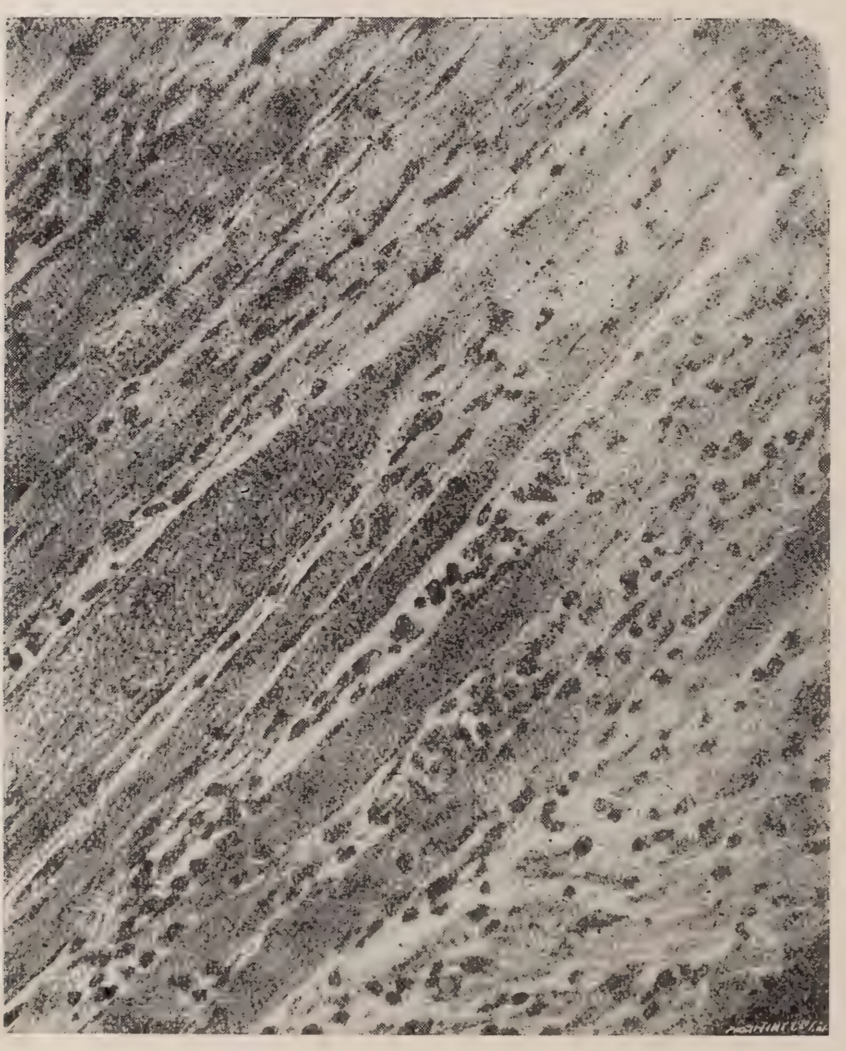
So far as I know, these facts have never been mentioned before in any works on surgery or anatomy, and may prove of interest.

ANTINOMYCOSIS BOVIS.

I have lately made some observations on a case of actinomycosis in the tongue of a cow, more especially with a view to determining the growth and arrangement of the mycelium. The published accounts vary very much in their descriptions, and some observers seem to have failed to find the mycelium at all. On reading the different accounts and comparing the illustrations given, I find that either the ray itself must vary very much in size in different cases, or the measurements given are incorrect; also the manner in which it stains must vary according to whether it is in a fresh or hardened condition.

In sections of the hardened organ I find it very difficult to stain the ray itself, and altogether impossible to stain the mycelium. This may of course be the result of the hardening method. I find the rays in this case, as well as in some others I examined formerly, to be much smaller than generally represented, and to be rather infrequent in their occurrence.

On the other hand, I find the mycelium permeating all the connective tissue under the superficial epithelium of the tongue, and in some parts even penetrating it. Wherever the mycelium abounds, there the section has a pale yellow appearance, except in those parts where it has set up an inflammatory action. Here there is typical inflammatory infiltration. and the leucocytes stain deeply. In only some of the inflammatory foci can rays be found, but this may be from the sections containing only a peripheral portion of an inflammatory nodule produced by the presence of a ray. It seems to me that the mycelium does not set up much irritation, but that the rays invariably do, and in many sections I have found the inflammatory action has gone on until disintegration is produced, and a minute abscess formed. The growth is not confined to the subepithelial tissue, but in places has penetrated into the epithelium and caused inflammatory action and breaking down there.



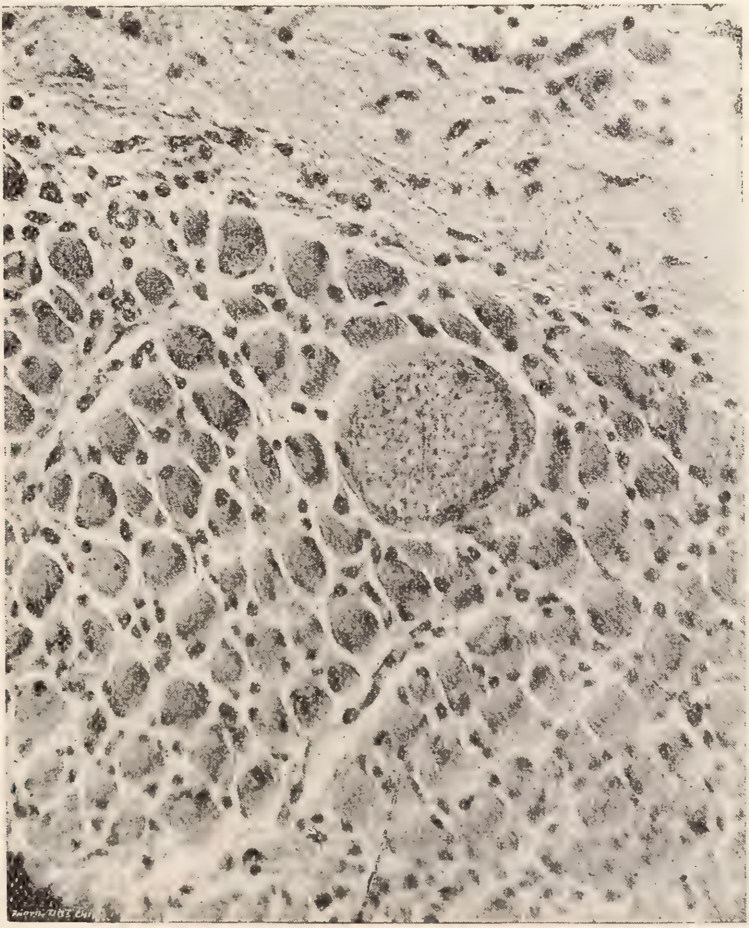
Portion of the Tongue of a Cow X 130.

Longitudinal Section.

I have also noticed a peculiar feature in the growth of this fungus, that is, the manner in which it penetrates a muscle fibre and increases in its interior.

The two accompanying photographs of this condition will fully explain it. They were taken with one of R. & J. Beck's $\frac{4}{10}$ in. magnification 130 diameters. In the one a muscle fibre is cut longitudinally, and has the mycelium occupying its centre; the other shows a fibre cut transversely. The appearances presented by these fibres are exactly similar to what have been described as Rainey's or Miescher's corpuscles.

Ziegler, volume 1, page 346 (English edition), says: "Our knowledge of the organisms known as 'Miescher's corpuscles' or 'Rainey's corpuscles' is still very defective. They are cylindrical or tube-like bodies, found not infrequently in the muscles of the pig, ox, sheep and mouse. They contain an innumerable multitude of small oval and reniform corpuscles."



Portion of the Tongue of a Cow X 130.
Transverse Section.

Claus, Text-book of Zoology, Protozoa, page 208, gives an illustration which is, I think, exactly similar to that I have described. He says, in describing the illustration: "Rainey's corpuscle from the flesh of a pig: (*a*) an animal inside a muscular fibre." He describes spores in a part more highly magnified. The appearance presented by sections of these muscle fibres are those that would be shown, when examined with a high power, if a fibre contained in its centre some substance of a much higher refractive index than that of the muscle itself, and careful illumination leaves little doubt that these appearances are produced by the growth of mycelium in the fibre.

After making a series of experiments with different reagents I have been able to show that portions of the rays are contained in the muscle fibres, and they are plainly made out with a high power as they stain quite differently to the mycelium.—*Pamphlet by the Author.*

THE MICRO-ORGANISM OF TRACHOMA.—SHONGOLOWICZ.

[TRANSLATED BY H. W. LOEB, M. D., ST. LOUIS, MO.]

From the *Centralblatt fur Bakt. und Parasit. VIII.*–25.

The writer proposed to attempt a discovery of a micro-organism in trachomatous tissue, and, in case one was constantly found, to determine exactly its nature.

After a careful review of the previous literature upon this question, the writer reported his own observations.

For experimentation he obtained the follicle contents of twenty-six patients with well-developed trachoma, in twelve of which it was necessary to cut the canthus.

In the contents of the follicles Shongolowicz found only by a special method of staining (a modification of the Gram-Weigert procedure) bacilli, 1–2 μ (.00004–.00008 in.) long, and 0.3–0.5 μ (.000012-.00002 in.) in thickness, most of them straight, and a few bent; they were seldom in pairs and were not connected like chains. The ends of the bacilli were rounded off. These bacilli could often be demonstrated in the tissues in large quantities.

For culture media he used 5 per cent. and 10 per cent. meat-peptone gelatine, 1 per cent. and 1½ per cent. meat-peptone agar, coagulated ox-blood serum, potatoes and beef tea. The cultures were placed upon the follicle contents, which had been previously broken up.

In this way the writer obtained three kinds of pure cultures :

First. Micro-organisms seldom found in the conjunctival sac, and especially :

(*a*) Three times, the potato bacillus.
(*b*) Twice, the hay bacillus.
(*c*) Twice, the sarcina aurantiaca.
(*d*) Once, the sarcina alba.

Second. Micro-organisms found somewhat frequently in the healthy as well as the diseased conjunctival sac, especially :

(*a*) Twelve times, the staphylococcus pyogenes albus.
(*b*) Nine times, the staphylococcus pyogenes aureus.
(*c*) Three times, the staphylococcus pyogenes citreus.
(*d*) Three times, the staphylococcus cereus albus.

Third. Micro-organisms, which in trachoma penetrate deeply into the conjunctival tissue ; these are found in the form of short bacilli in the seventh pure culture and correspond to the micro-organisms found by the writer in the degenerated trachomatous tissue.

This last bacterium is developed very well, but slowly when the follicle contents are placed in blood serum, meat-peptone gelatine, meat-peptone agar, potatoes and beef tea. The bacilli in the form of hanging drops exhibit rapid motion, but they never appear as chains. Gentian violet is the best stain for the bacillus. Their length is 0.75–2.0 μ (.00003–.00008 in.), and their breadth 0.3–0.5 μ(.000012–.00002 in.).

From the fact that the bacilli strongly interrupt the light at one or both poles, and that the color is intensified, the writer explains the appearance of micrococci as claimed in trachoma by earlier authors.

By inoculation of pure cultures upon the conjunctivæ of cats and rabbits, a disease identical with trachoma sometimes appears.

With respect to the constant presence of the bacilli in the altered conjunctiva in cases of trachoma, the writer's opinion is that they are probably caused, not by micrococci, but by short bacilli.

LECTURE ON PHAGOCYTOSIS AND IMMUNITY.

DELIVERED AT THE INSTITUT PASTEUR, DECEMBER 29, 1890.

BY DR. ELIAS METSCHNIKOFF,
Chef de Service de L'Institut Pasteur, Paris ; late Professor of Zoology in the University of Odessa.

[Translated from the Original Manuscript by J. G. Adami, M. A. M. B. Cantab., John Lucas Walker, Student in Pathology in the University of Cambridge.]

It is not possible to study the bacteriology of disease without noticing that, while in many cases the invading micro-organisms are to be found solely in the fluids of the body, in not a few affections they present themselves in the interior of certain cells, and this either partially—some being within the cells, others free in the blood plasma and the lymph that bathes the various tissues—or exclusively, all the bacteria that are visible being intracellular. Many of the facts bearing upon the terms of this relationship between tissue cell and micro-organism are now well known, yet it is worth while to recapitulate the more important, in order to show that from them it is possible to gain a general law ; and what is more, that from a study of such facts some insight may be gained into the phenomena of immunity.

It may, in the first place, be postulated that, whenever a micro-organism is discoverable within a cell, its passage thither has been by means of protoplasmic movements of amœboid movements either on the part of the microbe, or of the cell itself. The first alternative is the rarer, although it certainly exists, and of this the malarial parasite affords an excellent example; for here in the amœboid stage of its existence the hæmatozoon makes its way into the interior of a cell that possesses no active movements of its own, namely, the red blood corpuscle, and from the substance of this corpuscle the parasite gains its nourishment. Other sporozoa furnish instances almost equally good. More commonly, however, as in the case of all bacteria, where we have to deal with micro-organisms which, even when mobile, are destitute of protoplasmic appendages, it is the cells which play the active part; certain cells include the parasites. Of such, the amœbiform leucocyte of the blood and lymph is the most typical example, capable, as it is, of sending out pseudopodia in all directions, while a closely allied form is the cell of the splenic pulp. But there are also cells, as, for instance, those forming the endothelial lining of the vessels, which are very definitely fixed, which, nevertheless, can give off protoplasmic processes from their free surface, and so capture and include bacteria.

All these may be spoken of as *phagocytes,* and may be divided into the two broad groups of *fixed* phagocytes (endothelial cells, etc.) and *free* (leucocytes); not that the terms "phagocyte" and "leucocyte" are synonymous, for of the latter three main forms may be distinguished, of which one is practically immobile and never takes up bacteria. This is the *lymphocyte,* characterized by its relatively small size, its large single nucleus, and the small amount of surrounding protoplasm. The two remaining (phagocytic) forms are, *first,* the large uninuclear leucocyte, whose prominent nucleus is at times lobed or reniform, which stains well with aniline dyes and possesses much protoplasm and active amœboid movements —the *macrophage*—and *second,* the *macrophage,* a small form, also staining well, but either multinuclear or with one nucleus in the process of breaking up. (See Fig. 3.) If now we compare the endothelial cells with these, it is evident that their properties connect them closely with the macrophage; and, in fact, there is now little or no doubt that a very large proportion of the macrophages are of endothelial origin.

Leaving aside the subject of amœboid microbes and their life within animal cells, it is to the phagocytes and their relation to the bacteria that I wish specially to draw your attention.

Taking as wide a view as possible of this relationship, we can first determine that *the more malignant the micro-organism the rarer is its presence within the phagocyte.* Thus in those which of all diseases are the most rapidly fatal—in chicken cholera affecting birds and rabbits, in hog cholera ("cholera des porcs") given to pigeons and rabbits, in the anthrax of mice and other specially sensitive animals, in the "septicemie vibrionienne" * of guinea-pigs and birds, and in yet other diseases of peculiarly swift course—the corresponding bacteria are only very exceptionally to be found within the cells, but remain free in the neighborhood of their introduction, and thence invade the blood. For all the above-mentioned diseases are not localized, but, on the contrary, present the characters of general acute septicæmia, causing death within twenty to thirty-six hours, or, in certain cases, even within six hours.

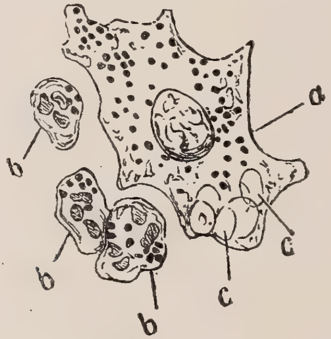


Fig. 1.—Staphylococcus pyogenes aureus contained in epithelial cell *a*, and leucocytes (microphages) *b b* of alveoli of lung of rabbit (Laehr), *c c* vacuoles.

And when we pass to those diseases in which the bacteria are to be found either in part or almost wholly within the phagocytes, the same law still applies; for in such cases the disease has lost its suddenness, tending to have a slower course, or, indeed, to be of a chronic nature. Even in those affections in which an acute course is accompanied by considerable phagocytosis, the fatal termination is far from occurring at the same early period as in the diseases recorded above. Thus mouse septicæmia, characterized as it is by frequent intracellular bacteria, has a duration in the mouse two and a half times as long as that of anthrax in the same animal. But in general a well-marked phagocytosis is associated with diseases presenting an essentially chronic development; it is in affections such as tuberculosis, leprosy, rhinoscleroma, glanders, that the specific bacteria are most readily taken up by the phagocytes; it is here that at the seat of the disease we meet with innumerable macrophages—epithelioid cells in which lie the individual microorganisms.

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* The disease produced by a micro-organism, which in appearance and methods of growth is curiously like Koch's cholera spirillum. Gamaleia, its discoverer, named it "Vibrio Metschinikovi"; and as such, in place of M. Metschnikoff's own vaguer "septicæmic vibrio," it will be spoken of in later reference to its properties. The disease it originates will be spoken of as vibrionic septicæmia."—Trans.

Further if we consider the phenomena associated with the resolution of an infectious disease, this inverse relationship between the malignancy of the malady and the occurrence of phagocytosis is, if possible, yet more clearly demonstrated. Notice, for instance, what obtains during the progress of relapsing fever, a malady still fairly common in Russia and other Sclavonic countries, and one which, while presenting many difficulties to the bacteriologist in that the specific spirochaete has so far resisted cultivation, and in that it cannot be communicated to the ordinary animals of the laboratory, is nevertheless in many respects not ill adapted for our present purpose. Here, during the sudden access of the fever, the spirilla are present in the blood in enormous numbers; they all are free in the plasma, and not a single intracellular spirillum is to be met with. During the apyretic (and in the monkey this is, at the

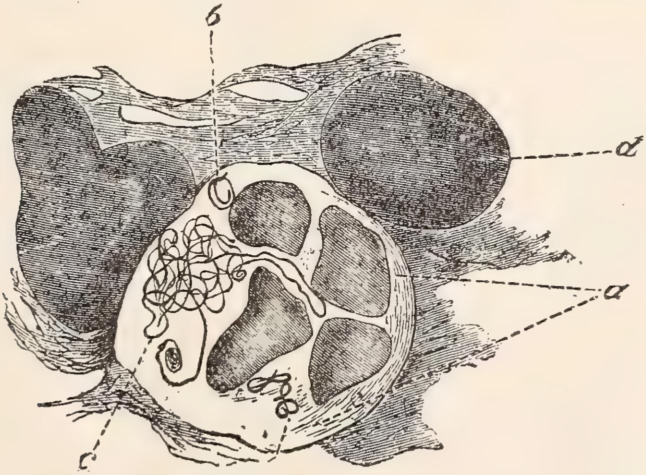

Fig. 2.—Resolution of acute infectious disease (relapsing fever), spleen pulp of monkey (Macacus erythr.), showing (*a*) a microphage, multinuclear, with incepted spirochaetes; (*b*) solitary, and (*c*) forming dense tangle, (*d d*) nuclei of splenic tissue (Zeiss. 1-18 ocular 4; × 1515 dim.).

same time, the stage of resolution) not a single free spirillum is discoverable in the blood, while the phagocytes of the spleen contain the microbes. The like phenomena repeat themselves in all those cases where it is possible to follow the fate of the micro-organisms of acute disease during the stage of recovery. Thus rats and pigeons very frequently survive an attack of anthrax, and, where this occurs, the bacteria, which at the commencement of the disease were for the most part free, now, during resolution, are for the most part included within leucocytes and splenic phagocytes.

Nor is this all; analogous phenomena as a rule attend immunity, which most often is but *recovery in operation from the very onset of a disease.* The more closely one studies this condition of immunity, the more is one led to the conviction that immunity and recovery are very intimately connected; that one can pass by slight gradations from the resolution of disease to the production of immunity. So it is that, in inoculating refractory animals with the microbe to whose action they have been rendered immune, it is found that the parasite *begins to develop, but that from the onset a reaction on the part of the organism shows itself,* accompanied by a considerable emigration of leucocytes which soon include the bacteria in great numbers.

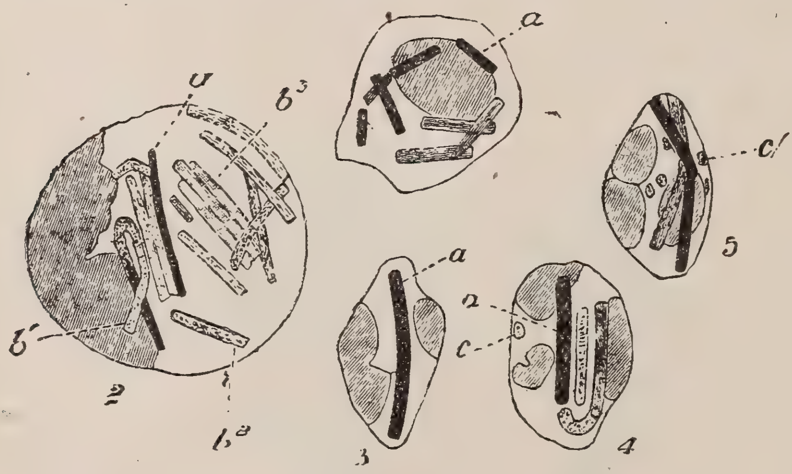

Fig. 3.—Anthrax of pigeon (an animal but slightly susceptible to the disease), to show stages of destruction of bacilli by phagocytes. 1 and 2, macrophages; 1, from exudation from eye of refractory bird; 2, from muscle of region of inoculation of bird that succumbed; 3, 4, 5, microphages—all from eye twenty-seven hours after inoculation; *a*, *a*, unaltered bacilli; *b*1, *b*2, *b*3, bacilli becoming more and more degenerated and indistinct; *c c*, *debris* of bacilli (Zeiss 1-18, ocular 3).

This relationship of phagocytosis to acquired immunity is in the highest degree instructive. Where a given species of animal is specially sensitive to the onslaught of one or other micro-organism, there, during the course of the disease, the phagocytes are inoperative, including none, or almost none, of the bacteria. On the other hand, when by previous vaccination these animals have been rendered refractory, their phagocytes have acquired the property of including the same bacteria. As an example of this, I may cite the action of the bacillus of anthrax and of the vibrio Metschnikovi. In ordinary rabbits the development of anthrax is only followed by a very feeble phagocytosis, while in vaccinated rabbits this phagocytosis is very extensive. Corresponding, but yet more strongly marked, differences are to be made out between the unvaccinated guinea-pig—an animal most readily affected by the vibrionic septicæmia—and the guinea-pig vaccinated against the same; after inoculation with the vibrio Metschnikovi, none of the vibrios are to be found in the cells of the former; in the latter the phagocytes are simply replete with the microbes.

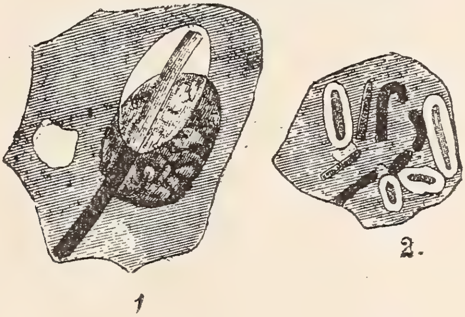

Fig. 4.—Phagocytes, macrophage and microphage, to show stages of digestion and destruction of bacilli, from spleen and eye respectively of white rat with anthrax. In 1, part of the bacillus is unaffected, but a vacuole has formed around the other part, which further has now lost the power of taking the stain. In 2, various stages are seen, the bacilli passing through the granular badly staining, to the vacuolated unstained, until finally but faint "shadows" are observable (Zeiss 1-18, oc. 3).

The facts enumerated thus far would seem to prove that there exists a certain antagonism between the microbes and the phagocytes, and this view is confirmed by the fact that in general the microbes find the interior of the phagocytes an unfavorable medium for their development and continued existence. Very often it is possible to determine absolutely that the parasites are killed within the phagocytes;

after inoculating refractory animals with bacteria, an afflux of white corpuscles toward the region of inoculation, followed by the inclusion of the bacteria and by their death, is seen to occur. These stages can be well followed where the anthrax bacilli are taken into the phagocytes of animals that are, or have been rendered, immune. They occur also with a long series of other micro-organisms studied in this connection, and among others in the case of the tubercle bacillus invading

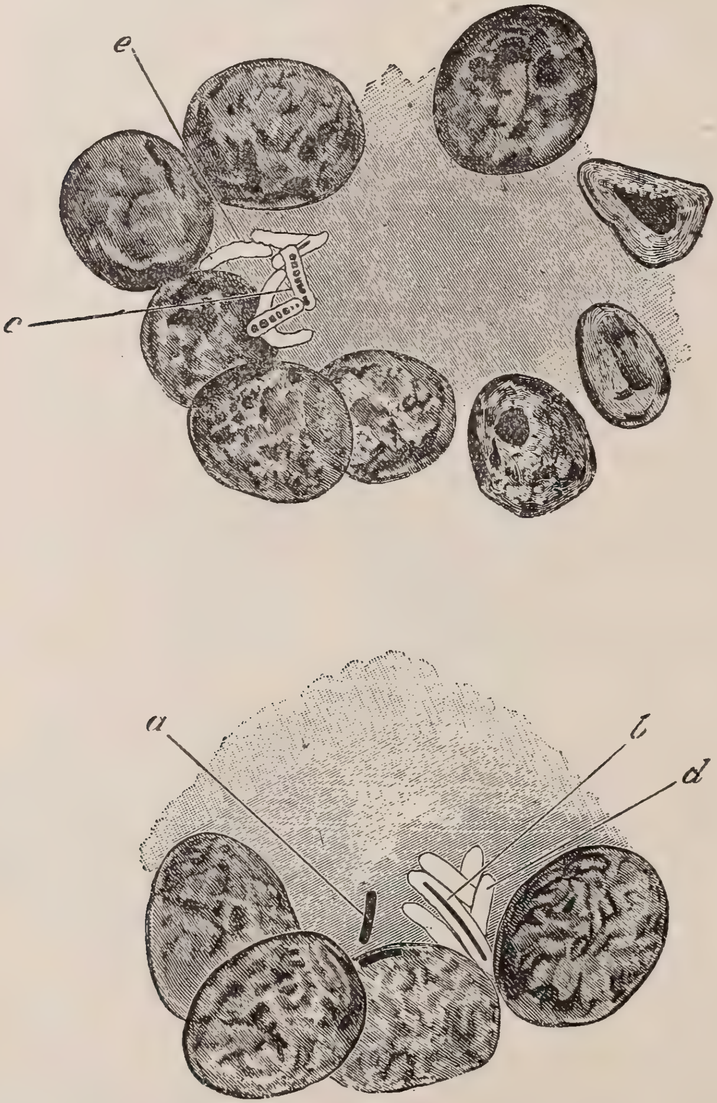

Fig. 5.—Two giant cells seen under high magnification (× 1515 diam.) from a rodent the spermophile, inoculated with tuberculosis, to show stages in the destruction of the bacilli. *a*, unaltered bacillus; *b*, bacillus staining badly, and with greatly thickened capsule; *c*, bacillus granular and breaking up; *d*, *e*, "shadows."

animals that are more or less resistant. The giant cells of tuberculosis are, in fact, huge multinuclear phagocytes ; and here the intracellular destruction of the bacilli is the more clearly demonstrable, inasmuch as the micro-organisms exhibit such very evident signs of degeneration ; the bacilli swell, their enveloping membrane becomes much thickened and highly refractive, and, in time, the contents lose their power of fixing the staining material, so that, eventually, nothing is left but slightly yellowish forms, recalling, in proportions and positions, the enlarged bacilli, and these shadowy bodies unite into small masses of an amberlike appearance. Analogous transformations never being observable outside the phagocytes—that is, to say, either in cultures or in caseating masses—these changes may well be regarded as due to a specific action upon the part of the giant cells.

The broad fact that the invasion of the organism by microbes most often induces, on the one hand, an inflammatory reaction with its associated emigration of leucocytes, and, that, on the other hand, the phagocytes are capable of including and destroying the invaders, leads us to admit that *the afflux of phagocytes to the invaded region, and their bactericidal properties, are mechanisms which serve to ward off bacterial attack and to maintain the integrity of the organism.* Where the phagocytes do not, either immediately or eventually, intervene, but leave the field free to the microbes, these last multiply without hindrance, and succeed in killing the animal, within, it may be, an excessively short period. Thus the micro-organism of hog cholera, which is left quite untouched, kills the pigeon in the course of a few hours—often, within five hours after inoculation ; chicken cholera kills not only pigeons, but also rabbits, in an equally short period. In other diseases in which the phagocytes appear upon the scene in relatively large numbers, and even include the micro-organisms, the latter gain the day whenever and wherever the phagocytes are incapable of destroying them or of preventing their growth.

This manifest bactericidal action is to be compared with the phenomena of intracellular digestion characteristic of amœboid cells in general, and of leucocytes and other microbic phagocytes in particular. These cells have the power of digesting, with ease, red corpuscles and other organized elements; just as have the amœbæ proper, and other protozoa. Among these last are many which have been found to include and transform bacteria in exactly the same way as do the phagocytes of the higher animal.—*The British Medical Journal.*

(*To be continued.*)

SCIENTIFIC GLEANINGS.

ON THE FORMATION OF STARCH INTO DEXTRINE BY THE BUTYRIC FERMENT.

BY M. A. VILLIERS.

(Note to the Academy of Sciences, Paris.*)

Having undertaken the study of the action of the figured ferments on the hydrates of carbon, in divers conditious, I will give here the first results relative to the action of the butyric ferment (bacillus amylobacter) on potato starch.

It is easy to transform the amylaceous matter into dextrine under the action of this ferment.

In large flasks, we introduce the starch of a potato and water not distilled, in the proportion of 50 gr. to 1 litre, the starch having been previously diluted with care. This mass is afterwards transformed into starching material by a jet of water vapor directed into the bottom of the flasks, agitating constantly, until the temperature rises to 212° F. After the condensation of the vapor, the flasks must be about refilled, in a manner that it only leaves a little volume of air on the surface of the liquid.

Then, the starch formed is inoculated with a few cubic centimetres of a culture of bacillus amylobacter. The flasks are then stopped with a stopper of sterilized cotton and deposited in an oven at 104° F. to remain some days. In these conditions, the spores of the butyric ferment, which, as has been shown by Mr. Van Tiegham, resist easily a temperature of 212° F. develop themselves rapidly. In inoculating the starch at 212° F. with the starch microbe, the development of foreign germs is more easily prevented. * * *

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* Comte's Rendus, page 435, February 23, 1891.

At the end of twenty-four hours, the starch is, in general, liquefied. Fermentation is allowed to continue until the liquid gives no more blue or violet reaction by iodized water. This result is attained more or less rapidly, after two to four days, sometimes only at the end of many days, owing to the existence of lumps difficult to attack. It is necessary, therefore, to make a starchy material as homogeneous as possible.

The bacillus presents itself, at the beginning, under the form of straight, short rods, very mobile. At the end of the transformation, it has uniformly thickened extremities, in the characteristic form of tadpole; the bacilli are then completely immobile. From this moment the products of the fermentation are modified no more.

Little, gaseous bubbles disengage themselves during this transformation of the starch, but the quantity of the gas disengaged is so small that it is impossible to gather any of it.

The liquid thus obtained is very slightly acid, and presents clearly the odor of butyric acid, but contains only an insignificant quantity of this latter (about 0.3 parts to 100 of starch).

Besides certain substances, which are also found in very small quantities, and to which I will return shortly, the principal products of this fermentation are constituted by dextrine, resisting the attacks of the *bacillus amylobacter*, at least, in the presence of other products, which are simultaneously formed.

We obtain them in precipitating the filtered and evaporated liquids and purifying them by further treatment with alcohol. The dextrine thus precipitated, added to that remaining in solution in the alcohol, represents the larger part of the starch employed.

Dried, they present themselves in the form of a perfectly white mass, light, friable, very greedy for water, which combines therewith, producing heat; it has a little sweet flavor, and is constituted by a mixture of different dextrines, as is shown by the variation of the rotary powers corresponding to the products of different operations, or even of fractions of precipitates of the dextrine resulting from a single operation. These powers varied from + 312.8° F. to + 405.5° F.

They transform themselves with difficulty into glucose by the action of water and acids. The transformation under the action of water does not seem possible at a cold temperature; it is very slow at 212° F. and hardly commenced at the end of forty-eight hours. Under the action of dilute sulphuric acid, it requires about a day at 212° F.

The iodine colors in red, the dextrine with the highest rotary power; the intensity of the coloration diminishes in them in proportion with the decrease of the rotary power; those in which this power is the lowest are not colored by the iodine.

They reduce cupropotassic liquor, and their reducing power is the greater that their rotary power is the more feeble, as we can judge by the following results, representing the weight of glucose which would reduce the same volume of reagent as 100 parts of dextrine:

Rotary power.	Reducing power.
156	28.9
175.4	11.3
207.5	5.0

New researches are necessary to decide if the dextrines are identical, or not, to those obtained by the action of the acid, or under the influence of diastase. But, at all events, their production, in the complete absence of maltose and glucose, is worthy of attention in the study of the constitution of amylaceous matter. On the other hand, this absence of glucose and maltose seems to show that the butyric ferment determines the transformation of starch into dextrine directly, and not by the intermediary of a diastase secreted by the organized ferment, diastase which should, judging from the analogies known, determine the saccharification of a larger or smaller quantity of dextrine.

THE AMMONIACAL FERMENTATION OF URINE.

BY VERANUS A. MOORE, M. D.,
Washington, D. C.

The fact is well known that urine undergoes putrefactive changes when it is allowed to stand for a considerable length of time at the ordinary temperature. In following these in the order of their occurrence we find that the clear urine first becomes faintly, then heavily, clouded, and finally, after several weeks standing, it clears with the formation of a considerable quantity of a grayish, more or less granular, sediment. The color of the cleared urine is always several shades darker than that of the fresh liquid. A further examination shows that its acid reaction is converted into an alkaline one simultaneously with the occurrence of the clouded appearance, and with this change in its chemical reaction the odor becomes penetrating and ammoniacal in character. The source of the ammonia was explained by the discovery of urea, and later investigations made by Prout showed that the urea was converted into carbonate of ammonia by a process of hydration. By "ammoniacal fermentation of urine," therefore, is meant that change in urine by which its urea is transformed into carbonate of ammonia. * * *

BIOLOGICAL HISTORY.

In 1860, Pasteur showed that in decomposing urine the transformation of the urea into carbonate of ammonia was due to a micrococcus which he found and designated as *Torula ammoniacale.* (*Van Tiegham, Miquel, Leube and Flugge described several forms of urine ferments.) * * *

To summarize, we have as organized ferments of urine already described six micrococci (Pasteur's, Flugge's and Miquel's), seven bacilli (eight if Miquel's *bacillus urea β* and Leube's *bacterium urea* are not identical) and one sarcina that are more or less active in the transformation of fresh into ammoniacal urine.

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* In parenthesis by the editor.

In considering the source of the organisms, we find that Pasteur, Van Tiegham and Leube isolated their germs from decomposed urine. Flugge does not give the material from which he obtained his mic. urea liquefacians. Miquel found the germs he described in the atmosphere, soil and water. Pasteur also found his *torula ammoniacale* among the germs isolated from the atmosphere.

In view of these facts, I have confined my investigations thus far principally to those forms of bacteria that are to be found within the healthy urethral canal. The object of such a limit was to determine, if possible, whether or not there are certain bacteria that are constantly present in this canal which act as exciting agents in the transformation of fresh into ammoniacal urine. If this question can be definitely settled it may be effectual in explaining the causation of certain cases of cystitis which are rapidly developed after the introduction of bougies and cathethers. Dr. Ricard finds that if these instruments are made aseptic that their introduction is harmless, providing the urethral canal is not infected ; but, if the urethral canal is already infected, it must previously be washed with a saturated solution of boric acid in order to avoid a subsequent more or less acute cystitis. It seems reasonable to suppose that if germs are found constantly within the healthy urethra that are active in producing ammoniacal urine that this canal as well as the instruments should always be thoroughly disinfected before any operation is attempted.

METHODS EMPLOYED IN COLLECTING AND EXAMINING URINE.

The methods employed, both in collecting the fresh urine and in its subsequent examination, are of much importance and worthy of careful consideration. The following precautions were rigorously adhered to in collecting the fresh liquid : The glands and external urinary meatus were carefully disinfected with either a 5-per-cent. solution of carbolic acid or 1–1000 solution of corrosive sublimate. The urine was passed directly into a sterilized Erlenmeyer flask, the mouth of which was previously flamed and the cotton-wool stopper replaced immediately after urination. Care was also taken to avoid dust and currents of air. A few cubic centimetres were immediately removed from the flask by means of a sterile pipette for a preliminary chemical examination. Only normal acid urine was retained for the bacteriological examination.

For the isolation of the germs the well-known Koch gelatine-plate method was employed. Esmarch rolls were at first tried, but on account of the presence of liquefying germs they were abandoned. In several cases a plate culture was made from the fresh urine by adding from ¼ to 1 cc. of it to a tube of liquid gelatine by means of a sterilized pipette, and, after thoroughly mixing, pouring the gelatine upon sterile glass plates. These were kept at a temperature of 65° to 75° F. These plates developed from one to four colonies, occasionally more, often none at all, showing how comparatively few bacteria there are in freshly voided urine. The flasks were allowed to stand at the ordinary temperature (65° to 75° F.) for from twenty-four to forty-eight hours, when the urine became clouded and either neutral or alkaline in reaction. A microscopical examination at this time showed a greater or less number of bacteria present. Plate cultures in gelatine were then made. One small platinum wire loop (holding from $\frac{1}{60}$ to $\frac{1}{50}$ cc.) of the fermenting urine was added to a tube containing about 10 cc. of liquid gelatine. After thoroughly mixing, from two to four loops of the first gelatine were added to a second tube of gelatine. The gelatine was poured on sterile plates. (These were carefully protected from external contamination by means of flamed bell jars. Sterile "double-dishes" were also used). They were kept at a temperature varying from 65° to 75° F. The number of loops taken for the first tube of gelatine depended upon the number of germs seen in the microscopical examination. When the germs were exceedingly numerous the first dilution was made in a tube containing about 7 cc. of sterile distilled water. The first plate usually developed innumerable colonies after twenty-four to forty-eight hours. The second plate as a rule developed from fifty to three hundred colonies. As soon as they were sufficiently developed they were examined both *macroscopically* and *microscopically* and a subculture made in sterilized urine and gelatine from a colony of each apparently different form. The plate cultures were repeated after the urine had reached its maximum degree of alkalinity, and again after it had been standing for from two to three weeks. In a few cases parallel plates in agar were made, but no germ was found to develop in this medium that did not grow on the gelatine. The subcultures were carefully examined, and all those in which the urine culture became alkaline were retained for more careful study. By this process I have isolated from urine about twelve forms of bacteria, mostly micrococci, of which five, on account of their property of producing ammoniacal fermentation in urine, will receive a somewhat detailed description. Of the remaining forms, one was a streptococcus which was present in every specimen of urine examined, two were bacilli, and the remainder were micrococci. The bacilli were very rarely found.

CULTURE MEDIA EMPLOYED IN TESTING THE REACTION OF THESE GERMS.

For a preliminary examination of these germs the ordinary culture media were employed, but, in order to test their power to transform urea into carbonate of ammonia, media containing that substance were necessarily resorted to. Of those sterilized normal urine seemed to be the most practical, as well as to afford a sufficient test for the property of the germs in question. Other media, such as acid-beef-infusion-peptone and gelatine plus urea, were also employed. Of the ordinary media, nutritive gelatine was the most important from a differential standpoint.

1. STERILE URINE.—This was prepared by distributing fresh acid urine in sterile culture tubes, about 10 cc. in each tube. As the urea is broken up by a high temperature the tubes were placed in a large water-bath and heated to a temperature of 149° F. for two hours each day for four consecutive days. Their sterility was tested by allowing them to stand for several days in an incubator at a temperature of 96.8° F. The urine remained in every instance clear and acid in reaction.

2. ACID-BOUILLON PLUS UREA.—This was prepared by macerating 100 grams of finely-chopped beef (freed from fat) in 200 cc. of distilled water. After standing for from eighteen to twenty-four hours in a cool place it was strained through a coarse linen, and to the simple beef-infusion ½ per cent.

sodium chloride and 1 per cent. peptone were added. It was then boiled for thirty minutes, cooled, filtered, and ½ per cent. urea added. The liquid was then distributed in sterile culture tubes and sterilized by heating at 149° F. for three hours each day for four consecutive days. It remained clear and acid after standing for several days at a temperature of 96.8° F.

3. ACID GELATINE PLUS UREA.—This is prepared precisely in the same manner as the acid bouillon, with the addition of 10 per cent. gelatine, which is added before the beef-infusion is boiled. The urea is added to the liquid gelatine after it is filtered. It is preserved in sterile, cotton-plugged test tubes, and sterilized by the same method as the bouillon, after which it remained clear and acid in reaction.

[*To be continued.*]

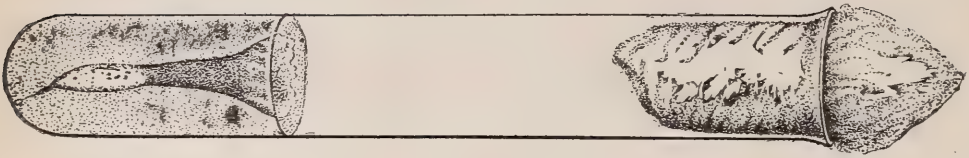

Fig. 1.

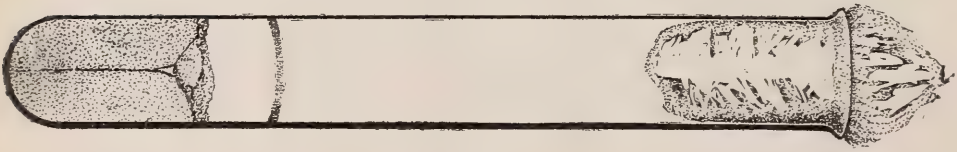

Fig. 2.

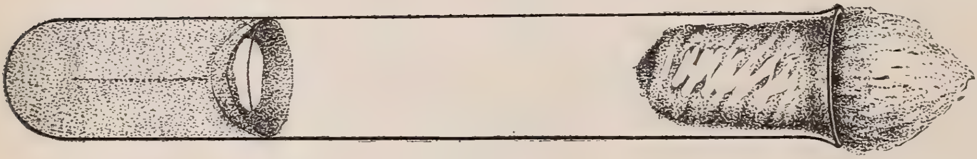

Fig. 3.

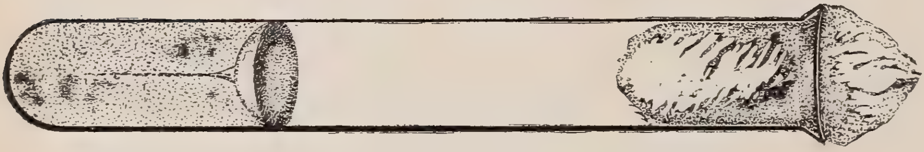

Fig. 4.

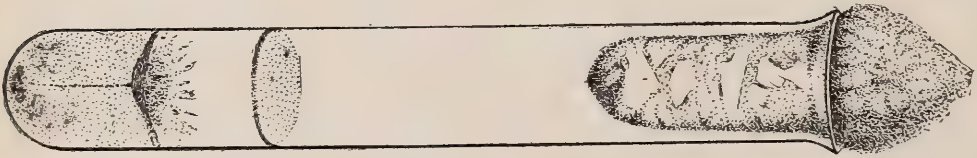

Fig. 5.

DESCRIPTION OF PLATES.

Plate I.

Gelatine needle cultures of the micrococci described.

Fig. 1. Micrococcus A—Culture seven days old.
" 2. " B " " " "
" 3. " C " six weeks old.
" 4. " D " " " "
" 5. " E " " " "

Plate II.

Drawings made from cover-glass preparations of urine cultures, one day old, of the micrococci described. The preparations were dried, passed three times through a flame, and stained for a short time with alkaline-methylene-blue. The position of the germs in the field was determined by means of Abbé's camera lucida, Zeiss 2 mm. apochromatic lens, No. 4 eye-piece.

Fig. 1. Micrococcus A.
" 2. " B.
" 3. " C.
" 4. " D.
" 5. " E.

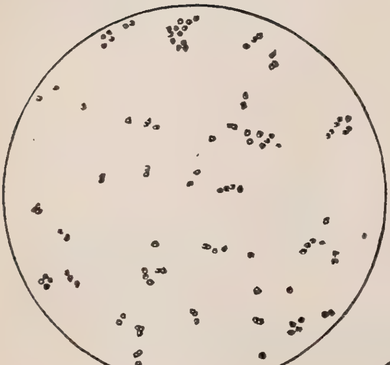

Fig. 1

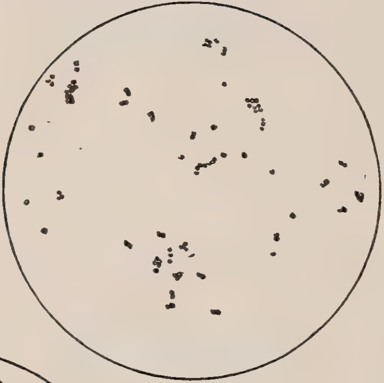

Fig. 2

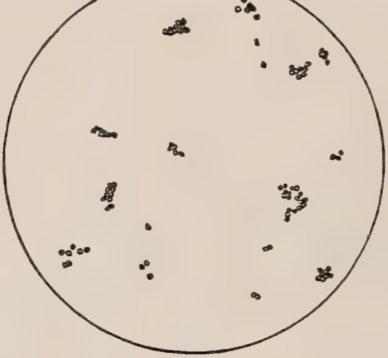

Fig. 3.

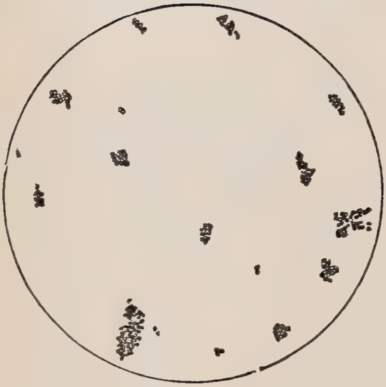

Fig. 4

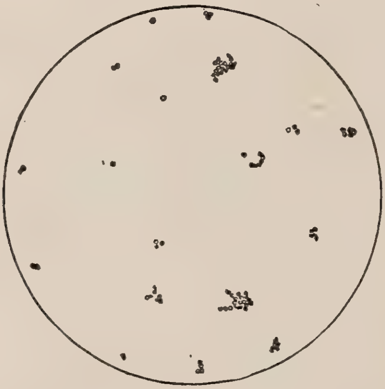

Fig. 5

Haines, Del.

Proceedings of the American Society of Microscopists.

TECHNIQUE.

RAPID STAINING OF TUBERCLE BACILLI FOR DIAGNOSIS.

BY PROF. V. A. LATHAM, ANN ARBOR, MICH.

The methods I prefer are Gibbes' Double and his Magenta, and, as a counter stain, Ziehl Neelsen's; though for permanent preparations I believe the two former methods the best, for by Ziehl's the bacilli lose the rose tint and become black.

To double stain at once :—

To make the solution :

℞	Rosaniline Hydroc.	3 grams
	Methyl Blue	2 grams

Rub up fine in a glass mortar, then dissolve aniline oil 6cc. in rectified spirits or alcohol 20cc.; add very slowly to the stains, rubbing up well till dissolved; then slowly add distilled water 20cc., and keep in a stoppered bottle and date it. To stain very quickly, pour in a thin watchglass a little of the stain; place the cover on which the caseous nodules of sputum have been spread evenly and thinly, * and then dried, sputum side down and press under with a needle. Then heat till it steams and fluorescence is seen, then let it stand covered for five minutes, longer if possible. When stained, wash well in plenty of alcohol till quite clean and all red color off; let dry and on the cover place a drop of C. Balsam, and lay on a slide. If the best results are desired the stain should be used cold and left for an hour. This method does away with all the acids and keeps well, and is certain if bacilli are present. It can be used for micro-organisms and bacilli in tissue, and is a gain as the tissue does not shrivel.—*Lancet*, May 5, 1883.

MAGENTA STAIN (*Dr. Gibbes*).

℞	Magenta	2 grams
	Aniline oil	3 cc.
	Alcohol (.830)	20 cc.
	Aqua, dist	20 cc.

Dissolve the oil in the alcohol and shake. Rup up crystals very fine with a little alcohol until all dissolved, then add distilled H_2O while stirring; keep stoppered, dated and labeled.

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* And, by aid of a sputum spreader, got from Eberbach's, Ann Arbor, Mich., this is easy.

To use stain.—Spread sputum as above, allow to dry in air protected from dust, or by heat if in a hurry. In any case, fix to cover by heat. Pour out magenta in a watchglass, and let the sputum cover lie face down for 20 to 30 minutes. While staining, make or keep on hand a 25-per-cent. to 33-per-cent. solution of HNO_3 (C. P.) in distilled water. Remove cover from stain and thoroughly decolorize in acid, then wash well in water distilled, and if the red color returns wash repeatedly in the acid and again in distilled water. Then stain in a 5-per-cent. solution of methyl blue, green or iodine green in distilled H_2O, and leave for 5 to 10 minutes; wash in distilled water until no color comes away; drain off water; wash in alcohol; let dry and mount. If it is desired to study the structure of bacilli, use a watery solution of chrysoidin in place of blue, etc. Care must be taken that the sputum is the first coughed up in the morning, as later it is often only from the back of the throat. Heating the stain will facilitate the process. The Germans, I believe, are giving up the value of bacilli as a reliable diagnostic point.

For actinomycosis.—A solution of Spiller's blue is recommended, and mount in C. Balsam, the fungus being unstained; or Gibbes' double-stain, if left in it long enough.

REMEDIES AND CLINICAL NOTES.

CAMPHO-PHENIQUE AND LISTERINE IN ALVEOLAR ABSCESS.

I was called hastily by a neighboring dentist to see a patient, Miss M., aged 24, who, he stated, was having a severe hemorrhage from the gum where a tooth had just been extracted. I found a good-sized abscess under the lower maxilla which, she stated, had been there for about three months. From three small incisions—to avoid scars—I gently pressed out blood and pus, and applied:

℞	Campho-phenique	ʒ iij.
	Lanolin	
	Vaseline	aa. q. s., ad ℥ j.

M. ft. ungt. Sig.: Apply night and morning, previously bathing the affected part with warm water. Also ordered internally:

℞	Quin. sulph	gr. xlviij.
	Tinct. ferri mur	℥ ss.
	Glycerine	℥ j.
	Aquæ, q. s.,	ad ℥ iij.

M. ft. Sig.: Two teaspoonfuls in water three times a day.

Also ordered:

℞	Fl. ext. hydrastis can	ʒ iv.
	Listerine	℥ j.
	Glycerine	℥ j.
	Aquæ, q. s.,	ad ℥ iv.

M. Sig.; Use as a mouth wash every two or three hours.

Patient returned to my office in about ten days with abscess almost cured, and looking much relieved in body and mind. I am continuing the same treatment. I omitted to say that I am relieving a congested portal circulation.

T. B. Kramer, M. D.

Washington, D. C.—*Medical Sun.*

A DETERGENT AND ANTISEPTIC WASH IN SCARLATINA AND DIPTHERITIC SORE THROATS.

℞	Acid. Boracic	ʒss.
	Chloral Hydrat	gr. x.
	Glycerine	ʒ iv.
	Katharmon	℥ ijss.

Mi Sig.: Dilute with water and thoroughly cleanse the fauces and ulcerated surfaces every 2 hours.

Dr. R. M. King.
(Prof. Beaumont Med. College, St. Louis, Mo.)

FOR NASAL CATARRH.

℞	Resorcine	gr. x.
	Glycerine	℥ i.
	Katharmon	q. s. ad ℥ iv.

M. Sig.: For spray.

Wm. Porter, M. D.
St. Louis.

MAMMITIS.

℞	Tarro- Petrolene	q. s.

Sig.: Apply in gentle friction over the inflamed organ twice or three times daily after washing and wiping dry. Leave a good coat of the ointment on the surface.

N. B. This treatment is very successful.

A. Rouif, V. S.
St. Louis, Mo.

*QUERIES AND ANSWERS.**

Under the above heading we will answer, as briefly as possible, short, concise rational questions of subscribers, concerning bacteriological subjects *only*. as far as accommodating collaborators and the editorial management may be able to.

Q. Who is the father of the theory of phagocytosis, Pasteur or Metschnikoff? Med.

A. The last-named scientist is the man. He is a Russian, formerly of Odessa, now Chief of Pasteur's Institute, Paris.

Q. To what kind of cells is the property of digesting bacteria, etc.,—phagocytosis ascribed? Med.

A. To fixed cells as those of the bronchial epithelium, for instance, and to cells of the order of leucocytes.

Q. How are specimens preserved (not mounted) in glycerine, and treated afterwards if desired to cut and stain? J. N.

A. Glycerine, by its avidity for water, distorts specimens. However, certain kinds may be preserved and hardened in it, and then sections made directly without further treatment. Before staining, the sections should be a long time in successive clean-water baths, treated with alcohol, and washed again until all traces of glycerine have disappeared. Specimens may be preserved in glycerine in using first 2 parts of it to 1 part of water, transferring after a week or so to purer and then later to perfectly pure glycerine. Three parts glycerine,

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*The 7th, 8th, 9th and 10th questions are kindly answered by Prof. T. J. Burrill.

2 of water and 1 of alcohol as first fluid is also used, followed with fluids of purer and purer glycerine. At best, we have found glycerine an inferior preservative for subsequent convenient manipulation of tissues.

Q. Is Bismark brown the same as Vesuvin? H. L. P.

A. Both are derivatives of diazobenzine and are consequently closely related if not identical, for an author states that the first named is partly soluble in distilled alcohol, and the latter is soluble in water. However, we found them about equally soluble in water, etc., and believe them the same reagent under a different name.

Q. Why is it that experimenters in aniline do not give the name, number and maker so that the dye can be obtained at some future period? R. JAMES.

A. Experimentalists, please answer. It would help the work along materially if the suggestions of this question were put in practice.

Q. Can anyone advise me regarding a camera, for both landscape and micro-photography, which is light and suitable for a lady's use for the former work? B. TAYLOR.

A. Will some one answer? We know of no combination of the kind.

Q. What is the best way to clear specimens of celloidin imbedding on a slide after cutting to get the tissues clearly stained?

A. It is usually best not to remove the celloidin from sections imbedded in this substance. If trouble is found it is probably from want of proper clearing, *i. e.*, making transparent. Try the following: Cut sections, using 80 per cent. alcohol during the operation. Place short time in 95 per cent. alcohol, then remove to slide; stain with alcoholic solution; clear with origanum oil, three parts, oil of cloves, one part; mount in balsam.

If, however, it is desired to remove the celloidin mass, use oil of cloves pure. If it proves necessary to fix sections on slide, use white of egg 50 cc., glycerine 50 cc. and salicylate of soda, 1 gram, well shaken together and filtered. Spread *thinly* on slide with brush, and lay sections on at once. Ninety-five per cent alcohol will now solidify the albumen and wash out the glycerine, which latter must be effectually disposed of if the object is to be mounted in balsam.

A still easier method of fixing such sections to slide is available when the celloidin is not to be dissolved out, viz.: Simply by blowing upon them some ether vapor from a bottle, arranged like a common wash-bottle, containing sulphuric ether. This partially dissolves the celloidin and causes the sections to adhere.

Q. How is the condenser used to get the exact focus so that an amateur can understand it?

A. Center the condenser by the use of a two-inch objective, or by removing both eye-piece and objective and looking down the tube.

I screw in an iris diaphragm in place of the objective, and remove both lenses from an eye-piece having a cap; then by opening and closing the diaphragm while looking down the tube, exact centering can be accomplished. Some condensers are furnished with a metal cap with central pin-hole—all ought to be so provided, for this matter of exact centering is very important. Now, to adjust focus of condenser, use a lamp set at least two feet at one side, edge of flame towards plane mirror. See that the latter is central, and reflect the light up through condenser. Lay on the stage a slide having a thin paper label, with the latter over the center of the condenser. A bright spot of light will show on the paper, and the condenser is properly focused when this is as small as it can be made—almost a mere point. If it is daytime, and light from a large window is used, the best focus is shown by the image of the window-bars, etc., on the paper label. Of course anything acting as a screen will serve the purpose of the paper label, but it ought to be on the upper surface of a slide of medium thickness.

Q. What is the best way to correct and adjust collar objectives?

A. Select a small dense particle of something under the cover for which the correction is desired. Most mounted slides will be found to have some little body which will answer for this purpose; but, to experiment, rub up a little charcoal or take the spores from the sooty substance on corn called smut. Mount a very little, such as these, in water and examine under the desired objective. Now move fine adjustment up and down from the proper focus. A dark ring will be observed around the object swelling in diameter as the objective is moved. When the collar is properly adjusted the size of this ring (coma) will be equal on both sides of the focus. The shade is usually deeper on one side than the other at best, but the enlargement ought to be the same.

Q. Why is it aniline varies so in its action, especially in staining T. bacillus when mixed in staining fluids?

A. In my experience it is not the aniline oil (provided this is freshly mixed) which varies in the staining of *bacillus tuberculosis* so much as it is other things in the manipulation. In Koch's original method he used one part of potash to ten thousand parts of water in connection with methyl-blue. This minute proportion of alkaline substance should show the necessity of having the staining fluid just right. The least acidity spoils the result. One of the sources of trouble is in the water used. My results have sometimes been better with rain water than with the distilled water obtained at a chemical laboratory, but subject to absorption of various gases.

Another cause of failure is in the overheating of the sputum in drying. Too long immersion in very hot stain also seems detrimental.

All this is upon the assumption that the irregularity observed is with the same sample of aniline oil. There is much variation in the commercial substance sold under this name.

Q. What is the method and object of mounting micro-organisms in tissues in monobromide of naphthaline?

A. See *Journal of the Royal Microscopical Society*, 1880, p. 1043 (Abbé. and others) for accurate reply. Will gladly publish some one else's opinion on the point.

LABORATORY NOTES.

FIRST ANNUAL REPORT NEW YORK PASTEUR INSTITUTE.

Dr. Paul Gibier, Director of the New York Pasteur Institute, begs to inform you of the results of the preventive inoculations against hydrophobia performed at this Institute during the first year of its existence (February 18, 1890, to February 18, 1891),—828 persons, having been bitten by dogs or cats, came to be treated. These patients may be divided in two categories:

First. For 643 of these persons it was demonstrated that the animals which attacked them were not mad. Consequently, the patients were sent back after having had their wounds attended during the proper length of time, when it was necessary.

Second. In 185 cases the anti-hydrophobic treatment was applied, hydrophobia of the animals which inflicted bites having been evidenced clinically, or by the inoculation in the laboratory, and in many cases by the death of some other persons or animals bitten by the same dogs. No death caused by hydrophobia has been reported among the persons inoculated.

Indigents have been treated free of charge.

The persons treated were:

81 from New York.
27 " New Jersey.
16 " Massachusetts.
11 " Connecticut.
9 " Illinois.
5 " Georgia.
5 " North Carolina.
5 " Pennsylvania.
3 " Maryland.
3 from Missouri.
2 " New Hampshire
2 " Texas.
2 " Kentucky.
2 " Ohio.
1 " Maine.
2 " Arizona.
1 " Minnesota.
1 " Iowa.
1 from South Carolina.
1 " Nebraska.
1 " Rhode Island.
1 " Arkansas.
1 " Virginia.
1 " Louisiana.
1 " Indian Ter.
1 " Ontario (Can.)

With kindest regards of the Pasteur Institute.

Paul Gibier.

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Those who honored us with a trial subscription of three months are respectfully reminded that the March number was the last copy to which they were entitled. We sincerely trust that the few who have neglected to forward the balance of subscription will continue their appreciated assistance to the cause of bacteriology in sending as early as possible after this issue the sum of $2.25.

OMISSION.

Omission in article entitled "Fistula in Ano in Phthisis," by Dr. Heneage Gibbes. At page 273, of this number of the BACTERIOLOGICAL WORLD, before the last three lines, read: "It is not generally known that a sinus exists in the normal contracted state between the external and internal sphincters of the anus," and then follow with: "This sinus is about one-eighth of an inch," etc., as will be seen on that page.

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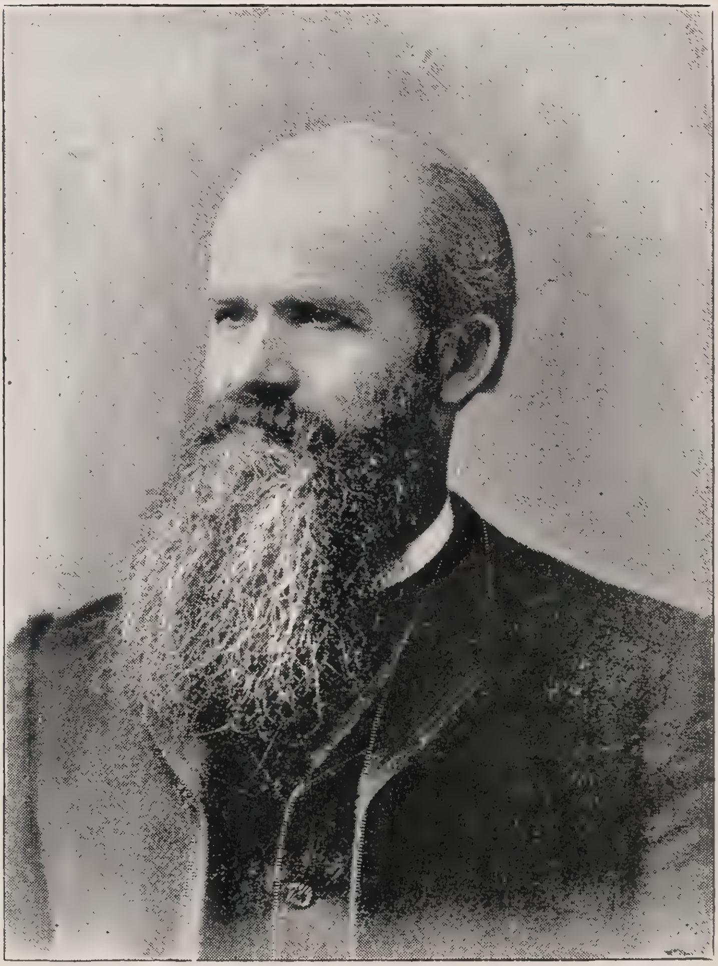

PROF. T. J. BURRILL, PH. D.

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EDITORIAL.

CHEMISTRY AND BACTERIOLOGY IN MEDICINE.

It becomes daily more evident that one no longer can claim to be thoroughly equipped to practice medicine without a fair knowledge of chemistry and bacteriology.

Time was—and most of medical colleges seem to think that time still is—when chemistry meant merely a glance at this science, to give an idea of the combinations of drugs, and their incompatibilities. The lectures to students and their very rare laboratory exercises, when any were followed, were directed chiefly in that direction. Incidentally the chemical constitution of the body, its liquids, etc., were touched, and mentioned also in connection with physiology. But, at the examinations, chemistry was, and is now in certain colleges, so conducted as to draw evidence from the students that they know the difference between a base and an acid, quinine and morphine, and such simple propositions. In many institutions the man who knows chemistry fairly well is still an exception.

Of late years, however, bacteriology has forced a deeper study of chemistry on all the progressive and conscientious teachers of medicine. Consequently, there is an awakening to the fact that medicine was practiced, haphazard, as an art, and the truths of it, the sciences underlying it, were ignored. Bacteriology has pointed to various transformations in cultures, and in animal and vegetable bodies. It has shown that microbes, though causing much disturbance, rarely cause serious troubles merely by their presence, but that they do by the chemical substances wrought by their various processes of feeding, at the expense of a living organism. Chemistry stepped in and demonstrated the nature of the products thus created by parasitic life, or by microbes, nourishing themselves at the expense of dead matter, such as in cadavers, cheese, cream, meat, oysters, etc., etc., or living matter such as the human body.

It is high time that medical men at the head of colleges recognize the fact that a deeper knowledge of the sciences of medicine is necessary for the greatest achievement in medical teaching and practice. One may follow an empirical rut without them, but no one can feel that he is doing his duty in teaching or practicing medicine in ignorance of the laws underlying the very base of physiology and pathology. Dr. Vaughan's very able paper on this subject, as read before the American Medical Association, at Washington, was timely, and should be read by every doctor and medical student in the country.

PROF. BURRILL.

We take a great deal of pleasure in presenting to our readers in this issue the picture of one of the oldest and most favorably known of the bacteriologists of the country. Indeed, Dr. Burrill is one of the foremost bacteriologists in the world, and his word on technology is authoritative everywhere. In the study of tuberculosis he rendered a very great service to all interested in that line of investigation, and especially to practicing physicians, by his clever combination of a simple method of staining the bacillus of tuberculosis. At the time this was done bacteriological technique was very crude. There were no simple methods nor any easy ones, and Burrill's stain was no little discovery. He has done much work in the bacteriology of plant diseases as well as the diseases of animal life. Science to-day owes much to his brains, energy and patience in working intricate problems. We regret much that we have not a list of the numerous literary works and deeds of valor of this advanced scientific thinker.

LESSONS IN BACTERIOLOGY.

LESSON FIFTH.—PART I.

BY PAUL PAQUIN, M. D.

CULTIVATION OF BACTERIA—STERILIZATION.

Good results can be obtained in bacteriological studies only on condition of absolute cleanliness in the laboratory and field manipulations. In the first place, bacteria cannot be studied with profit if mingled with numerous organisms. One cannot clearly understand the morphology or physiology of so minute microscopic beings in a field of observation in which different living particles strive for existence.

The first step then is the *isolation* of the microbes, *i. e.*, the separation of the different kinds in order to insure the study of each independently and in a state of purity. This isolation is effected by means of the cultivation of the organisms in various suitable media, the composition of some of which we have already seen.

The isolation of microbes is an extremely difficult task, and requires patience, integrity and a love of science. It means that every step, every manipulation, however slight, must be based on the greatest caution possible against all forms of contamination. The air, we might say, is simply full of germs, and could we but see the countless living organisms floating in the space in our laboratories or offices, for instance, they would appear as a dense cloud impervious to our vision. Every object, then, every vessel, knife or other instrument is the bearer of microbes, and must be freed before being used. In other words, these objects must be *sterile,* free from living forms of any kind.

We understand, then, that a reliable study of bacteria depends first on their cultivation and isolation, and that this can be successful only under the strictest sterilization methods.

Let us now go into details as to the various sterilization questions involved.

The room.—The apartment in which cultures and isolations of microbes are made should be as free from dust and floating bacteria as possible. This is better attained by using a very small room with perfectly smooth walls and ceilings, free from cornices, nooks, cavities, window sills, or anything else capable of catching dust and germs A room, say 6x6, with glossy walls, floors and ceilings, glazed or painted in such a smooth manner, and with such material as to admit of perfect cleanliness and disinfection, provided with only one light, is in my judgment the very best place to make cultures. Such a place may be shut air tight almost at night, a sulphur brick burned in the center of it, and thus sulphurous acid fumes be generated for several minutes, and the atmosphere of the room be much purified by contact with sulphurous acid gas for several hours. This room may also be purified by steam, or again it may be disinfected, rendered almost sterile by spraying a bi-chloride of mercury solution, 1 to 2,000, through the space in the evening, closing the room till the next morning when it may safely be entered.

The culture room should be kept sacred, and no visitors admitted. The oftener it is opened the more its atmosphere becomes polluted.

The operator should be clothed with a clean jacket, say a white tough cotton cloth coat, and overalls of same material; the sleeves might be protected by oilcloth sleevelets, such as grocers use sometimes. These clothes should be removed and left in the culture room every night when sterilization of the latter occurs, and they should be washed every week at least. The hands and hair should be well cleansed, so nothing therefrom shall contaminate instruments, etc. It is better, in fact, before doing anything in cultures and during the processes, to dip the hands occasionally in a solution of bi-chloride of mercury, 1 to 2,000, say, kept in a convenient place for the purpose. Rings should be removed from the fingers before putting the hands in this solution; otherwise they may be seriously damaged.

The instruments.—Of all the sterilization agencies heat is undoubtedly the most effective. But unfortunately it cannot always be applied with safety or impunity. Now it would be very difficult to sterilize a room, however small, by heat, unless it be steam, and even this is costly. Instruments, however, can most all be sterilized by heat of some kind. Heat as a sterilizer is applied either moist or dry, *i. e.*, hot water, steam, dry air or actual fire (flame, cauterization). It is important to utilize the least destructive of these kinds of heat in sterilizing instruments of various kinds.

Good glass instruments may stand either moist or dry heat, including a blaze, but a knife, a scalpel, a pair of brass or steel forceps would be ruined if kept in a blaze until a change of color occurs. A mercurial preparation is not injurious to glass goods, wooden ware, horny substances, etc., but is bad on the edge of a cutting instrument.

To sterilize instruments then it is desirable for the reasons above given, and many others too long to explain, to observe the following rules closely :

First.—Sterilize empty glassware at dry heat.

Second.—Sterilize glassware filled with culture media or other substances in moist heat.

Third.—You may sterilize the surface of knife blades, pincers, forceps or other iron, steel, brass instruments by passing them slowly in a gas blaze to kill the organisms on their surface, but never heat them long, or until steel blackness, dark red or whiteness is produced.

Fourth.—Platinum instruments, such as forceps with platinum points or inoculating needles, may be sterilized by heating white.

Fifth.—Cotton, wool, paper and like things should be sterilized only in dry hot air.

Sixth.—Clothes, towels, rags, handkerchiefs, etc., may be sterilized either in dry air or by steam.

STERILIZATION OF CULTURES AND ORGANIC MATERIALS. These should be sterilized usually by steam, though such as blood serum is sterilized by low dry heat. The details of such sterilizations will be given in speaking of the substances themselves.

The degree of heat in various sterilizations, whether they be dry or moist, is another important item. Now 212° F., as explained to you ere this, is usually high enough to destroy most of micro-organisms, in a very short time, both in dry and moist heat. But sometimes it is impracticable to raise the temperature that high and again it can readily and safely be raised very much higher. For instance, a beef-broth culture with gelatine sterilized once a day about 212° F, not higher, for say five or six consecutive days, will be prettier, clearer, and usually remain solid in warm temperature, whilst the same material sterilized at one heating over 212° will present often the reverse conditions; it will not remain solid in warm weather.

Again, blood serum, sterilized gradually at a low heat, will finally be free from germs and yet remain comparatively clear and transparent, whilst the same at high temperature will at once become white and opaque and unsuitable for most of cultures.

The apparatus for sterilization are now very numerous and many of them are costly, too costly in fact for daily use except in laboratories. The busy practitioner or the amateur, however, may readily sterilize most of things in the office or kitchen. The kitchen stove oven can well serve as a dry heat sterilizer, and the steam kettle or boiler as a moist heat (boiling water, water bath or steam) sterilizer. I have had occasion to try these and succeeded fairly well by repeated heating at temperature lower even than 212° F.

The special laboratory sterilizers are as follows:

A dry heat oven, consisting of a double wall metallic box, (sheet iron), about eight inches wide, six or seven inches deep and eighteen inches high, inside measure. A little opening at the top admits of a thermometer.*

Koch's vapor sterilizer: This instrument permits the raising of temperature very high, say about 324° F., thus destroying all organisms and their spores readily in a few minutes. Chamberland's autoclave is another sterilizer of the same kind. There is no difference in these high heat sterilizers except in their mechanical construction and convenience. All of them give the same results.

Besides these methods of sterilization in laboratory technique there is another now often followed in sterilizing certain liquids. I mean the Chamberland filter. The essentials of this apparatus consist of a hollow cylinder *bougie* of porcelain, closed at the bottom and provided with a smooth funnel-shaped point at the other extremity, over which may be adapted a piece of rubber tube. By a system of pressure or suction the liquid passing through this bougie is freed from micro-organisms.

(This lesson to be continued with figures in June number.)

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* By a misfortune the cuts to illustrate the instruments of this lesson have not been received, and will be used only in the next issue.

SURGICAL BACTERIOLOGY.

SURGICAL TREATMENT OF PULMONARY CAVITIES.

The bold endeavor to radically attack phthisical cavities and drain them, although introduced some years ago, has been lately receiving fresh advocacy, especially in relation to the treatment of phthisis by Koch's "tuberculin." Many of the dangers of this remedy in advanced cases of phthisis rest upon the retention of necrotic material within the lung, and the liability to its being inhaled into previously unaffected areas. Dr. Sonnenberg recently operated upon four cases undergoing this treatment, and Dr. E. Leser, of Halle, reports two more. One of these was a female aged 43, who had had symptoms for four years, and presented physical signs of excavation at the left apex. The operation consisted in making an incision in the first intercostal space, 7 centimetres long, and, after dividing the muscles and securing blood-vessels, introducing a trocar in the direction of the cavity. Although no fluid could be obtained, it was evident that the point of the trocar was in the cavity, and the pleuræ being firmly adherent an aperture was bored through the layer of tissue overlying the cavity by means of a Paquelin's cautery, the trocar being taken as a guide. The cavity was the size of an apple, had somewhat irregular walls, and was coated with flakes of inspissated pus and caseous matter; these were removed, and the cavity stuffed with antiseptic gauze. Subsequently, the patient was injected with Koch's "tuberculin," which always caused increased discharge from the cavity; and later still some of the fluid was directly introduced into the cavity itself. At the last report the patient had improved much in general health, and the cavity had dwindled to one-half its former size. The second case, a man aged 42, was similar, except that in him the cavity was no larger than a chestnut, and was situated at the right apex. Here, too, the use of tuberculin produced increased discharge, and on one occasion its injection into the cavity was followed by severe vomiting, dyspnœa, and other alarming symptoms.

Dr. Leser, however, thinks this mode of treatment has a future before it. At present he would make it a *sine qua non* that the costal and pulmonary pleuræ should be firmly united, as they usually are when cavities are of some standing, and he enters fully into the technique of the operation, laying stress upon having a fairly large incision through the thoracic wall, but not a very large aperture made in the lung, since this will be sure to increase by sloughing. The notable feature of these cases seems to be the immediate relief to cough and expectoration given by the external opening, although, when the injections are resorted to, the secretion becomes so much more abundant.—*The Lancet.*

HYGIENIC BACTERIOLOGY.

THE BACILLI OF MALARIA.

Dr. Andreas has recently published an interesting treatise on the comparative number of the bacilli of malaria in the air at different times of the day. His experiments, which were conducted in the Observatory of Moncalieri, and reported in the *Medicinische Neuigkeitten*, April 11, 1891, were carried out by means of small rubber balloons filled with hydrogen. On to these balloons he fastened a small box, holding prepared glass slides, which box he was able to open by means of a cord, after the balloon had reached the desired height. Microscopical examination of the slides showed that in the early hours of the day the swarms of bacteria were close to the ground and in large numbers; later, at about nine o'clock in the morning until about three in the afternoon, they would rise until they reached a considerable height, and from that time would again gradually sink to the ground. The number of bacilli in the air was almost exactly in proportion to the rise of temperature, while in direct opposition to the amount of humidity in the atmosphere. It is evident, therefore, that the condensation of the watery vapors in the air cause the falling of the bacilli, and for this reason the morning and evening hours are the most dangerous in malarial districts.—*Medical and Surgical Reporter.*

INFECTION THROUGH THE SOIL.

The question is often raised whether there is any direct or indirect proof of the infectivity of the bodies of those dying from specific fevers, or whether the soil of graveyards may become really dangerously contaminated thereby; but it is also one to which comparatively little attention has been given by the experimentalist. One aspect of the matter has been lately studied by Dr. Justyn Karlinski, of Konjica, Herzegovina; in a series of experiments (*Centralblatt f. Bakteriol,* ix, 13) undertaken to determine whether the organs of the body undergo any change in temperature during the natural process of decomposition after burial in the earth, and especially whether any differences in this regard are to be met with in the case of infected subjects. His results show that invariably the putrefactive process is accompanied by a rise of temperature above that of the circumjacent soil; and also that this rise in temperature is markedly higher when the parts examined have been taken from the bodies of men or animals who have succumbed to infective diseases than it is in the case of healthy bodies. He further examined into the question of the survival of the pathogenic bacteria in the affected parts, and states that the typhoid bacilli may retain their vitality in the decomposing spleen for three months, and are only completely annihilated by rapid putrefaction and the presence of a large number of the bacteria of putrefaction. Dr. Karlinski says that he had previously shown that typhoid bacilli could retain their vitality for a period of five months in soil, but that if the earth were thoroughly saturated with rain water they were destroyed in from seven to fourteen days. The part played by the soil in the origin of epidemics should not, he thinks, be underestimated, since typhoid bacilli can only exist in water a comparatively short time.—*Lancet.—Medical and Surgical Reporter.*

INFECTION FROM MILK.

In the *Glasgow Medical Journal,* for October, appears an account of an epidemic of erysipelas and sore throat, occurring among families supplied with milk from a certain farm. The most striking symptom was an intense inflammation of the fauces, resembling erysipelas of the mucous membrane, with swelling of the glands of the neck, and in some cases suppuration. In some, true erysipelas of the skin developed. The temperatures ranged from 102° to 105° F. during the first few days of an attack. Convalescence was attended by extreme prostration. No bacterial examination was made, but a clear connection was traced between the milk and the epidemic.—*Journal American Medical Association.*

TYPHOID AND PSEUDO-TYPHOID BACILLI IN RIVER WATER.

Dr. Cassedebat (*Annales de l' Institut Pasteur*), following up Rietsch's work on the river waters of Marseilles, gives the result of an examination of seventy specimens of water from which 250 cultivations were made, with the view of determining whether the Eberth bacillus is to be found in the waters of the Durance which supply a part of the city, where typhoid fever is endemic and often epidemic. In no case was he successful in finding the Eberth bacillus, but he was able to separate three bacilli—"pseudo-typhoid bacilli"—which resemble the typhoid bacilli in many respects. The plate cultivations are so much alike that unless all four can be seen together it is difficult to distinguish one from the other. None of the pseudo-forms are quite so toxic to white mice as the true form, and one of them is quite innocuous. Although Cassedebat was not able to find the true form in water taken from the water supply which was most open to contamination, he found that this was not because the bacilli could not live in water, as in distilled water to which a cultivation had been purposely added, he could easily distinguish its presence at the end of forty-four days, and, when added along with half a dozen other forms, he could find them at the end of seventeen days. He comes to the conclusion, therefore, that the true typhoid bacillus does not occur in water so frequently as is sometimes represented, and that one or other of the forms of pseudo-typhoid bacilli has in certain cases been mistaken for it.—*Exchange.*

ORIGINAL ARTICLES.

*EXPERIMENTAL RESEARCH ON PROFESSOR R. KOCH'S FLUID, WITH EXHIBITION OF CULTURES AND EFFECTS UPON ANIMALS.**

BY PAUL GIBIER, M. D.

Director of the New York Bacteriological Institute.

Having received a certain quantity of Dr. Koch's "lymph" in the beginning of January, I made several experiments with it, with the results of which I should like briefly to acquaint you.

These experiments were made :

A. Upon the cultures of tuberculosis.
B. Upon animals.
C. Upon patients.

A. EXPERIMENTS UPON CULTURES.—1. A milligram of "lymph" is added to five cubic centimetres of glycerin-agar, which is then inoculated with a liquid culture of human tuberculosis.

Result.—After fifteen days' sojourn in the incubator the whole surface of the agar was covered by a culture of tubercle bacilli.

2. Five milligrams of "lymph" were added to five cubic centimetres of glycerin-agar and inoculated as in the preceding experiment.

Result.—Fifteen days later the growth, although less abundant than in the first case, covered all the surface of the culture.

3. Fifteen cubic millimetres of the culture of the tubercle bacilli were mixed with an equal quantity of pure "lymph," and glycerin-agar was inoculated with it at the varying intervals of a quarter of an hour, and of one, two, nine, twelve and twenty-six hours. After a contact of twenty-six hours the cultures developed normally, as you can see by the tubes which I have the honor of presenting for your inspection. The bacilli themselves having sojourned for this length of time in contact

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* Read before the Medical Society of the County of New York, February 23, 1891.

with the "lymph" do not seem, on microscopic examination, to have been perceptibly modified.

B. EXPERIMENTS UPON ANIMALS.—I will only, among several, quote the following: 1. A guinea-pig weighing 774 grams inoculated with a cubic centimetre of culture of human tuberculosis, sterilized by gold cyanide, forms a large abscess after a few days, which extends over the greater part of the right thoracic and abdominal surfaces. This is found to contain an abundant quantity of caseous pus, and, while pure, numerous dead bacilli. The abscess healed without entailing skin sphacelus, and the animal increased in weight. His actual weight is 811 grams, giving an increase of 37 grams.

Several milligrams of "lymph," injected into this guinea-pig at different epochs, produced no reaction, even in the dose of eighty milligrams.

2. A guinea-pig inoculated November 22, 1890, with human tuberculosis by means of two cutaneous incisions in the groins, presented a slowly evolving tuberculosis. The inguinal nodes, at the end of three weeks, were as large as small nuts; the animal, while apparently well, had lost 40 grams, weighing 763 grams January 2. He was then given half a milligram of "lymph," and the successive days the following quantities:

January 3,	½	milligram.
" 4,	1	"
" 5,	1	"
" 6,	1½	milligrams.
" 8,	3	"
" 10,	3	"
" 11,	3	"
" 12,	3	"
" 13,	3	"
" 14,	5	"
" 16,	10	"
" 18,	10	"
" 20,	15	"
" 22,	15	"
" 25,	15	"
January 27,	15	milligrams.
" 30,	15	"
February 2,	30	"
" 7,	20	"
" 9,	25	"
" 10,	25	"
" 12,	30	"
" 14,	35	"
" 16,	75	"
" 18,	80	"
" 20,	100	"
" 22,	100	"
Total	640	milligrams.

Making a total of 640 milligrams in a little less than two months' time.

A reaction was only obtained after the injection of 30 milligrams. I should like here to remark that, given the weight of the animal, 100 milligrams of lymph would be equivalent to about ten grams, or 10,000 milligrams, for a man of ordinary weight, and the total quantity of 640 milligrams, equivalent to more that 64 grams or cubic centimetres, for the same man. The reaction, obtained after the injection of 30 milligrams and larger doses, manifested itself by an elevation of one or two degrees Centigrade of temperature. Neither the tubercular ulcerations nor the nodes were in any way affected.

Results.—They are absolutely unfavorable ; the animal has lost weight constantly, weighing at the beginning of the expermentation 763 grams, and to-day 645 grams, giving a loss of 118 grams, or one seventh of its entire weight, since the beginning of the injections. Moreover, as you can see, the cutaneous lesions of the animal, which I present you, have acquired an unusual intensity. The points of inocculation, which had cicatrized, reopened during the period of injections and became ulcerated, forming on the right side a raw surface of the size of a twenty-five cent piece. The ulceration of the left side is much larger and extends from the flank toward the back and around the thigh, and invades the abdominal surface. Other smaller ulcerations and tubercular nodules can be seen at a distance of a centimetre and a half from the main wound. Rare bacilli have been found in the tissue excised from the edges of this ulceration. Localized induration of the skin is found at about two centimetres and a half from the ulceration, and it is positive that a bacillar infiltration has taken place. The abdominal wall is infiltrated. The internal organs are apparently compromised, for respiration is notably accelerated, there being about ninety-six inspirations to the minute, and the animal having apparently but a short time to live. I intend to exhibit its viscera to the society whenever it dies.

I do not believe that this case can be considered exceptional, for similar results have been obtained and communicated to the Academy of Medicine, of Paris, by Professor Jaccoud, Professor Dujardin Beaumetz and Professor Dubief.

C. EXPERIMENTS UPON PATIENTS.—In consequence of the scarcely favorable results which have been published so far, I have not felt myself at liberty to accept more than three patients for the inoculations. Two of these patients have pulmonary tuberculosis capable of amelioration by the ordinary methods of treatment; the third patient, who has been operated upon several times in the past two years for tubercular genital lesions, had at the moment he presented himself for inoculations a tubercular lesion of the condyles and lower third of the left femur. Although the articulation is comparatively mobile, the leg is several centimetres shorter than it should be, and complete extension cannot be obtained; walking is only possible by means of crutches, and the slightest contact is painful.

The condition of the two patients with pulmonary tuberculosis has not been visibly ameliorated by the injections. The third patient with tubercular bone affection has seen his pain disappear so that neither pressure nor blows upon the diseased parts is any longer painful.

He has increased over four kilograms (nearly ten pounds) in weight in five weeks, his weight at the beginning of the treatment being 63.6 kilograms. He is always forced to use crutches, although able to lean upon the foot of the affected side, a thing he could not do less than a month and a half ago. I have believed myself warranted, in view of this condition of affairs, in continuing the treatment by injections, although I have deemed it advisable to add to it an iodine medication and a special diet.

Conclusion A, The addition of a milligram of "lymph" to a cubic centimetre of culture does not prevent the development of the tubercle bacilli.

Tubercle bacilli can develop after an interval of several hours (twenty-six hours at least) of contact with pure "lymph."

Contrary to what would appear from certain recorded cases, even the direct action of the lymph upon the tubercle bacilli does not produce any appreciable morphological or biological modification.

B. The injection of the "lymph" of Professor Koch, contrary to his assertions at the Berlin Congress, and in his subsequent communications, exercised no inhibitory action, even in considerable doses, upon the development of the but slightly advanced tuberculosis of the guinea-pig in the above-mentioned experiment.

C. The history of the patients of whom I have spoken, as well as the careful study of the observations published, warrants my opinion that in other than cases of tubercular lupus or of specific bone lesion the "tuberculin" of Koch is inefficacious.

Taking into consideration results similar to those I have described, we could conclude that we are, for the moment, assisting at the spectacle of one of the greatest medical and scientific delusions that has ever existed, and that the remedy in question should be completely rejected from therapeutics. Still, the reaction which takes place, according to many case records, at the diseased foci, the favorable results obtained in certain special cases (lupus, tuberculosis of the larynx, of the bones, etc.) permit us to believe that the new remedy could be of use not only as a method of diagnostic but also as a precious adjuvant to other methods of treatment of tuberculosis. This is a view of the case which, in so far as I know, has been as yet but little studied, and which, it seems to me, merits consideration.

STERILIZED MILK AS INFANT FOOD.

Read before the Missouri State Medical Association, Excelsior Springs, Mo., May 20, 1891.

BY PAUL PAQUIN, M. D.

The heavy mortality of bottle-fed babies owing to the unsuitableness of the food which they are forced to ingest, and the meagerness of their development in many instances when they do resist the strain of unnatural food on their delicate alimentary canal, has been noted and deplored by the civilized nations a very long time. The medical world has long been searching for means to effectually remedy the evil. The chemists, bacteriologists, have been for many years experimenting with a view to overcome the disaster among the babes and young children. As a result we find our pharmaceutical markets now filled with various artificial foods, all with claims of superiority on the other.

Some of these foods contain absolutely no milk, nor any true elements of the milk. Others are formed of milk partly, with the addition of other ingredients; such is condensed milk. Others again contain milk elements in the form of a powder. Still others are the result of a process of evaporation of milk. And, finally, we have a number of more or less valuable or more or less unwise medico-dietetic formulas with or without milk.

All this comes from the quandary in which the parents and physicians are placed when they are confronted with an infant so unfortunate as to be forbidden, by some cause or other, the use of a mother's milk.

These various foods, however, whether containing milk or not, except in one instance of a sterilized evaporated cream which I will mention further, have not succeeded in replacing the mother's milk, at least in the very young, though all of them have more or less value as foods at certain ages and in certain conditions. For a very young child, there is as yet no absolute substitute found for healthful human milk so far as its digestibility in a human stomach is concerned. The nearest to it is cow's milk, though many pretentious opinions have been given on the subject which tend to depreciate its value as infant food.

In comparing the composition of cow's milk and of human milk we find (in taking Doyere's analysis as the average of a number of analyses of authoritative experts) the following elements and proportions:

	Water.	Butter.	Casein.	Albumen.	Sugar.	Salts.
Woman.....	87.38	3.80	0.34	1.30	7.00	0.18
Cow..........	87.60	2.20	3.00	1.20	4.70	0.70

We see that the average cow's milk contains 2.66 per cent. more casein than the human milk, 1.60 per cent. less butter, 2.30 per cent. less sugar. The other differences of composition are comparatively unimportant.

A baby's digestive organs, then, are by nature prepared to digest at the outset only 0.34 parts of casein in each quantity of milk sucked from the breast. If it is fed cow's milk it receives at once, without its stomach being prepared by a gradual augmentation, 3 parts of casein or 2.66 per cent. more than it was prepared to or supposed to be capable of digesting properly immediately after birth.

But these differences in the constitution of the milk are not the only causes of disturbance in the digestion of infants. We must consider also that breast-raised babies get every two or three hours milk warmed by nature's process in the mother's breast, absolutely free from any of the *ferment-producing organisms* which cause the curdling, souring and decomposition of milk, whilst bottle fed babies, on the contrary, get cow's milk warmed by artificial heat to such a degree, sometimes, that the casein, already difficult of digestion because of its excess, is coagulated and toughened, and, from the moment of milking to the hours of feeding, it receives germs from the udder, the hands, the cow's hair and skin, and too often manure and urine even, not counting the innumerable air micro-organisms which fall constantly into the fluid.

Thus we have three grave objections to a true substitution in every particular of cow's milk for human milk: *First, the differences in the constitution; second, the differences* between *naturally* and *artificiallg* warmed milk; *third,* the differences between a milk *free* from the *contamination* of ferment organisms and that of the milk wherein they may *exist* or may have *existed* and caused transformations. It would seem then that it were a simple thing to efface most of these differences and bring cow's milk very close to the composition and nature of human milk. Not so, however. What in theory appears feasible is practically beyond perfection with our present means and knowledge.

Still we may effect some intensely useful and practical corrections, bringing the two kinds of milk very close in their physiological effects on the system of the infant, so much so indeed that, by the use of improved cow's milk, in foundling asylums, where the tender innocents generated by heartless sensuality, thrown to the mercy of selfish and cruel humanity, never know the loving care of a mother, and where the ratio of death was from 75 per cent. to the appalling number of 100 per cent. in summer, the death rate has been reduced to 25 per cent. These figures were given by physicians in charge of such institutions in large eastern cities. Now how are we to effect these changes and save the babies in the homes and the asylums? Let us examine into the problem.

First as to the constitution: Here we should add fat, extract casein, and add sugar. Unfortunately, it seems at this date that the best we can do is to add a little water and sugar, and trust to nature to become competent to digest cow's milk, after gradual preparation of the infant's stomach and sterilization of the milk. More further on this point.

Second as to the warmth: Milk just from the breast or the udder seems to have a *vital property* not well determined. The fresh, warm product of living cells is, we would infer, a nourishment containing vital energies to be found nowhere else in nature. As it flows from the breast of a healthy mother into the infant's stomach, it passes directly from life to life without any interference or influence playing on its nature.

Now what occurs in cow's milk warmed artificially? If it does contain a vital principle the cooling process and the heating again, between the periods of milking and the periods of feeding, doubtless devitalize it, if I may so speak, particularly if a high temperature is used. I must admit, however, that this conclusion is theoretical, and inferred from physiological laws.

Third, as to the contamination with micro-organisms: This is by far the most important and most complicated question of the three.

I need not go into a lengthy discussion to prove that the transformation of milk is due to the growth of micro-organisms.* It is a recognized fact that the souring and curdling of it, as occurs daily in the ordinary course of things, are due to microscopic living beings. The effect of ozone in a thunder storm seems to hasten the souring, but this particular result is an exception and seemingly a chemical action, which has no bearing at any other time possibly than in electrical storms. The soured condition is merely the condition of milk in which lactic acid has been formed from the sugar it contained, by the feeding and digestive processes of germs. The coagulation or curdling is likewise the result of germ life.

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* A French author recently advanced the theory that the micro-organisms in question are animalcules, and that souring, etc., is not due to bacteria proper.

The process of the transformation of milk after milking is as follows:

First, the production of *lactic acid* by the micro-organism, commonly known as the lactic acid ferment, which develops and feeds itself at the expense of constituents of the milk. This acid then causes coagulation. As the milk grows older, other micro-organisms feed upon the coagulated portions, as well as the fluids, and produce other transformations with the natural results of chemical products, which I do not intend to discuss here.

I need not say that milk so affected by micro-organisms is injurious to the young. You all have seen ill effects of feeding cow's milk in various conditions, ages of the subject and atmospheric temperatures. You all know that lactic acid, butyric acid or other products of milk fermentations (or decompositions) are not well tolerated by the stomach of the infant, and that various more or less disastrous results follow, particularly during warm seasons, when the germs develop more quickly.

But when we compare these results in the young with those of feeding similar milk in the older children and the adult we, at first, fail to comprehend why there should be such a difference. In my judgment the matter is readily explained by the difference in the process of digestion between the suckling infant and the older children or adults eating and masticating food, and the action of micro-organisms on the milk.

In the first place, the stomach of a babe does not contain muriatic acid, whilst that of the masticating child or adult person does. Therefore, the stomach of the former is not prepared to stand the irritant touch of lactic acid, which is formed before or after entering it by the action of the germs that contaminate the cow's milk. In the masticating human being the stomach contains muriatic acid, and is capable of receiving such irritant agents.

Again, in the babe, the muriatic acid which is a fine destroyer of many forms of microbes being wanting, all germs, not excluding the souring and curdling ferments which have entered the digestive tract with the cow's milk, grow uninterrupted. They vegetate, multiply with wonderful rapidity, producing thereby irritant poisonous ptomaines perhaps, gas, or other bacterial products throughout the alimentary canal, and the result is, diarrhea, cholera infantum, gaseous colic and other more or less dangerous disturbances. In the stomach which is old enough to secrete muriatic acid, on the contrary, the many germs ingested meet first this acid, which may in part arrest them in or retard their vegetation. But, should any escape and fermentation follow in the stomach and intestines, or should a masticating human being swallow milk already altered in various ways by microbes, the stomach and bowels are usually found *accustomed to the digestion and partial fermentation or decomposition* of various foods, and are prepared for and capable of resisting the irritant and disturbing properties of bacterial and ferment products.

Perhaps, we will realize these facts better in bringing the digestive phenomena of milk in the infant and adult to our minds.

In the suckling infant, the comparatively small proportion of coagulable matter of the human milk, or the great amount in cow's milk, coagulates in the stomach by the action of the so-called rennet ferment, comparable to the rennet in calves. In the adult, coagulation occurs in the stomach also, but by the acid of the gastric juice instead of the special ferment principle of the stomach of infants. So coagulation of milk in all human beings occurs in the stomach, but by the action of different principles. In neither case, however, does the coagulum formed redissolve in the stomach. The particles of coagulated casein pass on into the intestines and there meet the intestinal juice which digests them. The ferment capable of dissolving casein curds seems to exist in the pancreatic secretion. Thus, the infant's stomach, prepared to receive only about 3-10 of casein in each quantity of milk swallowed, can well dispose of this minute proportion even if it were ingested after infection by various microbes, but when it comes to pour into it cow's milk containing an average of 3 parts of casein for each portion, and full of ferment germs and decomposing bacteria, we at once produce an abnormal amount of clotted milk in the stomach, which in itself sickens the babe. Then this extraordinary amount of casein passes into the intestines, and there fails of digestion because of the deficiency of pancreatic secretion in the infant. What occurs in such circumstances? Why the casein is attacked by various micro-organisms, decomposed by them, and various irritant products of a gaseous liquid or solid character are produced which cause disease.

It seems evident, then, that to the action of micro-organisms upon milk and to the surplus of casein in cow's milk we must attribute the severe diseases of the digestive organs of bottle-fed babies. These infinitely small, these microscopic plants, we must charge chiefly with the appalling death rate among children reared on cow's milk.

To remedy the evil, as I have said already, a great number of artificial foods, and various processes of preparing or rearing infants deprived of a mother's breast milk have been recommended. Perhaps the first and oldest means tried to substitute mother's food was the wet-nurse, and to this day she is recognized in many cases as the only means of saving a recently born child's life. Indeed, the very first days or weeks, it is doubtful if any mode of procedure can take her place if she be of *the right constitution, temperament, and in good health.* But, unfortunately, the circumstances attendant to a wet nurse's life are almost always seriously objectionable from many standpoints. It may be from a moral point of view. There are nearly always either some moral or physiological or pathological objections. Sometimes all these exist.

In the first place, the woman who lends herself to such services, if she is honest, has very frequently a heavy sorrow on her heart which is incompatible with the best nutrition and the secretion of the healthiest of milk. In the second place if she is indifferent in her condition she may present dangerous constitutional defects produced by a life of shame or more or less debauchery. It the third place there is always the dangers of occult tuberculosis, scrofulotic and syphilitic taints. In the fourth place their fees are beyond modest means. Fifth, most of them become tyrannical; in their knowledge that once their task begun, even at an exorbitant price, they hold the mother and father in their clutches for many months, they often become most disagreeable persons to deal with. And finally the death rate or ill health of children so reared is not much below that of careful artificial feeding by a good mother and an intelligent physician.

All the artificial foods you know well. All are more or less nutritious and often constitute excellent accessories to the diet of a child or an invalid, but none can be used exclusively for baby food. The evaporated cream termed "Highland Brand," which is represented as a sterilized article, is, on account of the sterilization, and because it contains no addition of foreign substances perhaps the only canned milk that, with proper care, could serve as exclusive food for young children. I mean to test its value in the near future.

But in daily practice, in the cities, in towns or rural districts, there is, in my judgment, a means to overcome in a great measure all the difficulties cheaply. It is the only means which I can find which is simple, accessible to all classes, rich or poor. I mean the sterilization of cow's milk at home and the addition thereto (in case of very young or delicate cases) of substances such as will make it as near human milk as possible.

In the first place, as to the preparation of the milk:

It should be very fresh, and have been milked in a most cleanly manner in the cleanest of vessels, preventing any kind of dirt from contaminating any portion of it. Then to each half-pint or pint of milk distributed in nursing-bottles add about one-half to one tablespoonful of water previously boiled, and about two to four teaspoonfuls of *chemically* pure milk sugar. Then plug each bottle with a stopper of ordinary batting cotton and put in the sterilizer.

A sterilizer consists of a steaming or boiling apparatus intended to raise the temperature of the milk sufficiently high to kill all adult germs and retard the growth of their spores, or sufficiently high to destroy both the micro-organisms and their spores. The first method is termed pasteurization.

The apparatus for sterilization consists of copper-bottom receptacles receiving a small amount of water which will readily generate steam in a few minutes when exposed to a sufficiently hot fire. The steam rises through the bottles full of milk. The Arnold sterilizer is a good example of this kind of apparatus. It can be purchased for about $3.

An ordinary boiler or steam kettle, however, may be substituted for these sterilizers. For instance, milk may be sterilized by placing the milk bottles wrapped in cloths in such a vessel before the temperature is raised.

Pasteurization means the raising of the temperature sufficiently high to destroy the adult germs and retard the growth of their spores into new organisms. It was found that a heat of 180° F. to 200° F. thirty to forty minutes, followed with a rapid cooling of the milk, effects this aim without coagulating the casein in so hard and tough particles, as is done by higher temperatures.

A temperature of 212° F. kept up twenty to thirty minutes effectually sterilizes the milk, so far, at least, as ferment microbes are concerned, and paralyzes other organisms, but the coagulation of the casein is naturally denser than at a lower heat.

A temperature above 212° F. coagulates casein too seriously ; it becomes somewhat indigestible even to individuals secreting pancreatic juice in sufficient abundance, and, besides, all high temperatures seem to devitalize milk (as before stated, if this expression may be used) and make it less desirable for the nutrition of infants. Still, in summer time at least, it becomes necessary to raise the temperature to about 212° F., unless the milk can at once be placed in a cooler—a cool cellar, say, immediately after the operation.

My practice has been usually to heat the milk prepared as above about thirty minutes at 212°F. immediately after milking in the morning in sufficient quantity to last all day and all night. Each bottle is plugged separately, and when opened for use, if there remains any amount of milk after nursing it is thrown away and new one opened at next nursing.

If it is found that the casein causes constipation and colic consequent thereon, a little gelatine melted in boiled tepid water—say a teaspoonful of a saturated solution to each half-pint—is added to the milk before sterilization. This seems to act mechanically in englobing the casein when formed into particles of coagulum or curd.

It will be seen by the foregoing that the objects of this method of preparing cow's milk are, first, to make it as near the constitution of human milk as we can in the present condition of science; second, to destroy or arrest all germs capable of producing any kind of fermentation or decomposition of the milk elements including the undigested casein.

By this means we prevent the generation of irritant acids, ptomaines, and possibly toxalbumens and toxic proteids, which, we all know, many different micro-organisms are capable of producing.

But it does more. If per accident any germs of tuberculosis or other animal diseases are present in the milk they, too, will be paralyzed in their respective actions, and thus the milk will become purified.

SELECTIONS.

CHEMICAL RESEARCHES ON MICROBIC SECRETIONS.—TRANSFORMATION AND ELIMINATION OF THE NITROGENIZED ORGANIC MATTER BY THE PYOCYANIC BACILLUS IN THE MIDST OF A DETERMINED CULTURE.

BY MESSRS. A. ARNAUD AND A. CHARRIN.

Before the Academy of Sciences, Paris, France.

Is pyocyanine, this coloring matter so characteristic of the culture of the pyocyanic bacillus, in direct connection, as to quantity, with the functional activity of the bacillus? This is the first question which presents itself to the mind when we endeavor to give an account of the utilization and transformations that the organic matter introduced as nourishment in a culture undergoes.

The analysis shows that the formation of the pyocyanine is very secondary, its proportion varies within slight limits, from 3 milligrams to 6 milligrams per litre, even in the cultures relatively colored sufficiently; inversely, in cultures almost colorless, we can ascertain that a considerable quantity of nitrogenized organic matter has been transformed by the bacillus into products almost elementary.

The principal products that are created are ammonia and carbonic acid. We have sought to follow the phases and the stages of these transformations and to study their mechanism.

Our first trials had for starting point beef-broth with addition of nutritive salts; but, in this medium so complex, it is difficult to follow the modifications of the organic matter; we had later recourse to a liquid artificial culture of determined chemical composition in order to restrain the field of researches.

The following mixture is particularly favorable to the development of the bacillus:

	gr.
$PO^4 KH^2$	0.100
$PO^4 Na^2 H + 12 Aq$	0.100
$CO^3 KH$	0.134
$Ca Cl^2$	0.050
Crystallized asparagine	5.000

Water, a sufficient quantity to make a litre.

Twenty-four hours after inoculation of this liquid, the temperature being maintained between 77°F. and 86°F. the greenish blue color manifests itself clearly, and gradually becomes more pronounced until the sixth or seventh day.

By exact dosing, we have followed, hourly so to speak, the progress of the assimilation of the asparagine.

We thus notice that the proportion of ammoniacal nitrogen capable of being set free by MgO, small at first, increases unceasingly until the fifteenth or sixteenth day, when the culture stops for want of nourishment.

The asparagine decreases very rapidly; sixty hours after the beginning of the culture it is already impossible to reveal the presence of it; on the other hand, at the outset we are able to ascertain the formation of aspartic acid[*] combined with the ammonia; this acid is, however, assimilated immediately during its production; it disappears about the seventy-second hour; at this moment in fact, the examination of the curve of the diagram[†] indicates that almost all of the nitrogen is already passed into the state of ammonia, save, of course, that which has contributed to the formation of the protoplasm of the bacillus. It is necessary to take into consideration also a small proportion of nitrogen which enters into some combinations not yet definite, probably very interesting from a physiological point of view, and which we will notice to-day only to determine its relative quantity.

RESPECTIVE QUANTITY OF THE SUBSTANCES WROUGHT AT THE EXPENSE OF THE NITROGENIZED MATTER.

	gr.	per 100
Nitrogen contained in the 5 gr. of asparagine to 1 lit. of culture	0.933	
Nitrogen eliminated in the state of ammonia (A) by hydration of the asparagine under the influence of the pyocyanic diastase	0.4655	50.0

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[*] The assimilation of the aspartic acid appears to be an essentially vital phenomenon, proper to the pyocyanic bacillus; we have not been able to ascertain the presence of intermediary products between it and the ammonia.

[†] The diagram was presented to the Academy for illustration.

Nitrogen eliminated in the state of ammonia by the vital action properly so-called of the bacillus on the aspartic acid, formed by the diastase..........	0.3835	41.1
Nitrogen found again in the protoplasm of the bacillus (the weight of which being 0.410 gr.) (B).......	0.0435	4.66
Nitrogen in organic combinations not yet determined (D)..	0.0385	4.04
Nitrogen of the pyocyanine. Loss..................	0.0003	

OBSERVATIONS.—A. The volatile bases are constituted by the ammonia : We have analyzed the crystallized salts, oxalate and chloroplatinate ; there is formed, however, a trace of methylamine, the presence of which we have been able to reveal by the appropriate treatment of a large quantity of oxalate of the total volatile bases.

B. The weight of the microbes vary with the age of the culture ; it can attain 0.670 gr. towards the sixth or seventh day.

C. In varying the weights of the asparagine (we have employed 20 gr. of this substance per litre), we obtain in the same time the same products and absolutely in proportional quantity. * * *

D. The weights of these substances can be estimated at 0.300 gr., by the difference of the weights of the extracts of the filtered culture.

* * *

Let us add, then, that according, to the following experiments, the bacillus splits the asparagine by hydration by means of a diastase ; in fact, if the liquid of a culture by the *bougie* has nearly no action on the asparagine *in vitro,* the bacilli collected on the *bougie,* washed and mixed in a solution of asparagine containing chloroform[*] in order to prevent all vital action, splits it in the following known equation $CO.\ AzH^2—CH.\ AzH^2—CH^2—CO^2H + H^2O = Co^2AzH^4—CH.AzH^2—CH^2—CO^2H$. We explain easily why this diastase remains fixed in the most part on the microbic protoplasm rather than passing in the filtered liquid, by the great experiments of Wurtz[†] on the fixation of the papaine on the fibrine.

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[*] This liquid remains acid, contrary to that which occurs in the culture where the microbe evolves.

[†] Wurtz, *Comptes rendus,* t XC, p. 1379, t XCI, p. 787.

THE CONTAGIOUSNESS OF GONORRHŒA.

In discussing the contagiousness of chronic urethral discharges, in the *Journal of Cutaneous and Genito-Urinary Diseases,* March, 1891, Dr. George Emerson Brewer, of New York, says the practicing physician is frequently called upon to answer inquiries regarding the limit of the contagious stage of gonorrhœal urethritis. The question is a serious one, especially when considered in its relation to marriage, and should be regarded as equal in importance to that of syphilis.

It has not infrequently been Dr. Brewer's experience to be consulted by young men, a few weeks or months before a contemplated marriage, with a history of one or more attacks of gonorrhœa in former years, and who believed themselves to be well; yet who upon a careful examination presented the unmistakable signs of a chronic urethritis. The only evidence of disease remaining in these cases frequently was the presence in the urine of small thread-like bodies, to which the name of *Tripperfadden* has been given by the German surgeons, who first described them and demonstrated their importance. These minute shreds are composed of mucus, pus and epithelium, and represent the secretions which adhere to any granular patch or area of chronic inflammation remaining on the urethral mucous membrane.

In consulting the standard authors upon the subject of genito-urinary diseases, one is impressed by the marked difference of opinion, regarding the contagiousness of chronic urethral discharges. held by those whose reputation and experience entitle them to the foremost position in the discussion of this question. As early as 1785, Kuhn called attention to the fact that the discharges resulting from a gonorrhœa remained contagious so long as they contained pus. The opposite opinion was held by Hunter, who denied the possibility of contagion from the gleety discharges of a chronic urethritis. This view was also shared by Bell and Ricord. In a paper entitled "Gonorrhœa a Non-specific Disease," published in the *New York Medical Independent* in 1864, A. K. Gardiner strenuously denies the contagious element in any, save the discharges from the most acute stage of the disease; and says regarding gleet that it is "allowably benign and innocuous." Noeggerath, on the other hand, in a paper published in 1872, concludes that a man who has once been the subject of a gonorrhœal urethritis never fully recovers ; that the disease invariably lingers in the glands and ducts emptying into the canal, and may at any time furnish a secretion which may infect those with whom he has sexual relations. He also states that nine-tenths of all women married to men who have had gonorrhœa sooner or later become the subject of incurable and painful inflammatory disease of the uterus, tubes or ovaries ; that this infection may take place rapidly, and manifest itself as an acute affection, or by means of a slow and unrecognized process to which he gives the name of "latent gonorrhœa." In a subsequent paper, read before the American Gynecological Association in 1876, the author reiterates these opinions, and adds that 90 per cent. of all cases of sterility can be directly traced to gonorrhœa.

Without entering into any discussion regarding the correctness of these views, which have been the object of considerable criticism, the fact remains that these papers had the effect of calling attention to a source of female disease and suffering, the importance of which had not, until their publication, been adequately recognized. This difference of opinion upon so important a question is not to be wondered at, when we consider that, at the time these views were enunciated, nothing definite was known regarding the etiology of this disease. Since the discovery by Neisser, in 1878, of the gonococcus, and the (Dr. Brewer thinks) establishment of its relationship to this disease, but one opinion can logically be held by those who accept his theory of gonorrhœal inflammations, and that is, that all secretions containing this micro-organism are capable of transmitting the disease under favorable conditions. In his recently published work upon this subject, Ernest Finger emphasizes this point, and states regarding marriage, that it should be absolutely prohibited in all cases where the existence of a chronic urethritis is evidenced by the presence of the "morning drop" or *Tripperfadden* in the urine, until the following facts have been established :

First. That after from two to four weeks of daily observation, the secretions from the urethra are found to be *free from pus and made up wholly of epithelial cells.*

Second. That no gonococci can be detected by the microscope, even after a purulent discharge has been established by the employment of irritative injections of corrosive sublimate or nitrate of silver ; and

Third. That neither prostatitis nor stricture exists.

Dr. Brewer says that, upon first becoming acquainted with the views expressed by Finger, he regarded his conditions as unnecessarily severe, and his opinion of the danger as greatly exaggerated. But a somewhat remarkable case, which came under his observation, illustrated in a most striking manner the fact, that, unless some of the precautions advised by Finger had been insisted upon, the responsibility of a dangerous illness would justly have rested upon his head. The case is reported by Dr. Brewer, and fully justifies the inferences he draws from it.—*Medical and Surgical Reporter.*

LECTURE ON PHAGOCYTOSIS AND IMMUNITY.

BY DR. ELIAS METSCHNIKOFF.
Pasteur's Institute, France.

[CONCLUDED.]

Now, in determining the intervention or non-intervention of the leucocytes in this war between the organism and the bacteria, a very great part is played by the sensitiveness of these cells to external influences, and especially to the chemical composition of their environment. The leucocytes are powerfully attracted by many micro-organisms and the resultants of their growth, and as powerfully repelled by others and their resultants, or, as it is expressed, they have a *positive chemiotaxis* for certain microbes, a *negative chemiotaxis* for others. The existence of these chemiotactic properties has been so clearly proved of late by the researches of Leber, Massart and Bordet, and Gabritschewski, that I need not enter into a fuller explanation of the subject here. Where *negative* chemiotaxis manifests itself, there, being shunned by the white corpuscles, the parasites freely propagate themselves and induce the death of their host. Nevertheless, this chemiotaxis is not immutable, and the cells can become accustomed to substances from which they shrank at first—a negative may thus be transformed into a positive chemiotactic state. Such obtains in acquired immunity; the cells which, in the unvaccinated animal never included the bacteria, now, in the vaccinated, take them up readily.

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There is not a single portion of the theory which I have just expounded but has encountered a lively opposition. Even the fundamental fact that the phagocytes are capable of including the microbes has had doubts thrown upon it; it has been held that the latter insinuate themselves into the former. Only after successive series of observations upon the phagocytes and the living microbes, has it been proved that assuredly it is the phagocytes which, by the aid of their pseudopodia, themselves include the micro-organisms. The observer can see the whole process in the case of immobile bacilli, can see the leucocyte approach, send out pseudopodia, and gradually include the individual bacillus. Or, conversely, in cases of negative chemiotaxis, one can, in blood taken from the monkey during the access of relapsing fever, observe the actively moving spirilla come into contact with a leucocyte, and even become attached by one end to its surface; yet, however active the movement, one never finds that the spirillum succeeds in piercing the surface and gaining an entrance. If it be suggested that this entry may take place in consequence of the force of active growth and elongation of bacilli, then, apart from the fact that here but one set of cases is embraced, it can be determined that this force is too feeble—it can be seen that, during the active growth of the anthrax organism in the blood, the elongating chains of bacilli curve in and out between the corpuscles, but never penetrate the cells.

From another side, the objection has been formulated that, in many cases, the organism gets rid of its invaders without the aid of the phagocytes. According to those who support this objection, this happens in the anthrax of pigeons (Czaplewski), and of refractory rats (Behring, Franck), in symptomatic anthrax of various refractory animals (Rogowicz), and in the septicæmia of vaccinated guinea-pigs, due to the vibrio Metschnikovi (R. Pfeiffer). A re-examination of the cases here adduced has, however, shown that in each a very considerable phagocytosis can be proved, and that the negative results of the above observers have been due to insufficient methods of observation.

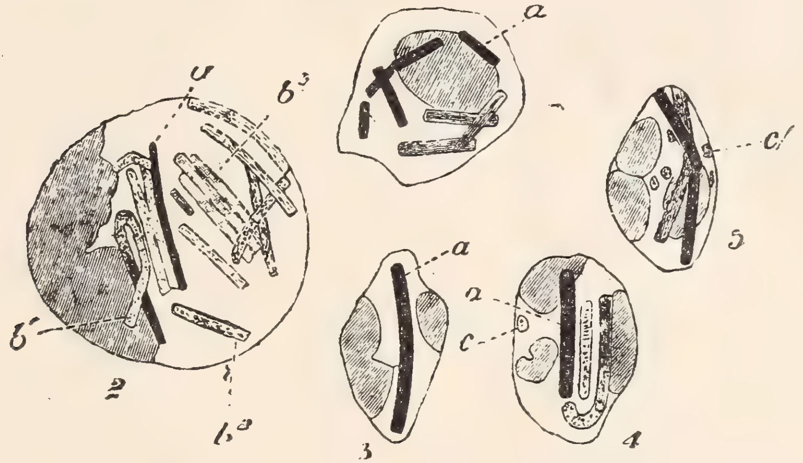

Fig. 3.—Anthrax of pigeon (an animal but slightly susceptible to the disease), to show stages of destruction of bacilli by phagocytes. 1 and 2, macrophages; 1, from exudation from eye of refractory bird; 2, from muscle of region of inoculation of bird that succumbed; 3, 4, 5, microphages—all from eye twenty-seven hours after inoculation; *a*, *a*, unaltered bacilli; *b*1, *b*2, *b*3, bacilli becoming more and more degenerated and indistinct; *c c*, *debris* of bacilli (Zeiss 1-18, ocular 3).

While accepting that the phagocytes do truly absorb the micro-organisms, other opponents of the theory have urged that these cells are only capable of including micro-organisms already killed by other means, and that living microbes are solely to be found within the cells in those cases where there has been a fatal ending—in tuberculosis, mouse septicæmia, and so on. Against this may be brought the fact determined by Lubarsch, that the phagocytes of several animals, refractory to anthrax, take up living bacilli that have been injected with greater eagerness than they include those which have been killed before injection. But, further, this objection may be disposed of by direct observation of bacteria undergoing development from within the interior of phagocytes after the latter have been destroyed by a substance which is at the same time a favorable medium for bacterial growth, as, for instance, beef broth. Such observations have been made upon pigeons, rendered immune to anthrax.

During the last year or two, great stress has been laid upon the fact that the bodily humors themselves possess most marked bactericidal properties, and, in fact, against the theory of phagocytosis has been brought another, based upon this power of the humors to destroy the micro-organisms. Observer after observer has remarked, that, in blood plasma, defibrinated blood, blood serum, and in the blood as a whole, in the removed aqueous humor and other fluids and exudations of the body, many species of bacteria perish, after a longer or shorter interval; and, forthwith, an endeavor has been made to find in these facts some elucidation of the phenomena of immunity. Yet, the more deeply one examines into the question, the more one is convinced that no relationship exists between the two. Thus it happens often, that the bactericidal property is more developed in susceptible species than in refractory; so with regard to the anthrax bacilli, in the very sensitive rabbit the bactericidal properties of the humors are more pronounced than they are in the refractory dog; and Behring and Nissen, the two who almost simultaneously first drew our attention to these phenomena, in their combined research, recently published, admit that, as against the bacteria of anthrax, pneumonia and diphtheria, this bactericidal property exists to the same degree in the juices of animals of the same species, whether they be susceptible or have been rendered immune. Often, again, it has been determined that the blood removed from the organism has a greater power of destroying bacteria than it has within the organism. A small quantity of blood withdrawn from the body will, in certain instances, kill a mass of bacilli greater than that which, injected into the circulation, would inevitably cause death. Evidently, therefore, in this bactericidal influence, extravascular phenomena enact an important *role*—phenomena, that is, which have no connection with what occurs in the living refractory organism.

From another point of view, strong arguments have been directed against this theory of the tissue fluids. It has been shown, specially by the researches of M. Haffkine, that the death of the bacteria transported into organic fluids is largely due to the sudden change of medium, and that, in passing from one medium to another by successive slight modifications in the fluid of growth, it is easy to make bacteria live in fluids which, when the change of environment has been abrupt, swiftly lead to their destruction.

In order to gain an idea as to the part played in the refractory animal, by the fluids and the phagocytes respectively, the endeavor has been made to separate the two by placing under the skin of frogs (which are naturally immune to anthrax) minute packets formed of filter paper, or of animal membrane, and containing the bacilli. The paper, while permitting the passage of fluid, wards off the wandering amœboid cells for a certain time. Shielded in this way from the phagocytes, though exposed to the action of the juices, the bacilli grow well, and produce the characteristic felted mass of anthrax filaments. Baumgarten has not been able to confirm this experiment, but Hueppe and Lubarsch have repeatedly verified it.

But it is not even necessary to take these precautions, in order to assure one's self that anthrax spores germinate in the juices of refractory animals. Recently, for instance, M. Trapeznikoff has found that, when these spores are injected into the dorsal lymph sac of the frog, they constantly tend to develop into bacilli, whose further growth is stopped by the phagocytes, which include them, along with such spores as have not had time to germinate. Eventually the bacilli so absorbed are digested by their hosts, while the included spores remain intact, although incapable of giving birth to bacilli for so long a time as the phagocytes remain alive. And I might adduce other similar cases. Such a comparative examination proves that in the living body the bactericidal property resides in the phagocytes, and not in the fluids.

Still, it may be urged that possibly these cells, which can thus devour and destroy the living microbes, are only in a position to attack bacteria whose virulence has already been lessened by other means. Were this so, the microbes present in a refractory organism should behave, not like parasites, but as simple, inoffensive saprophytes. Hence, these microbes—powerless to produce upon a refractory soil the toxic substances which render them pathogenic and dangerous—should easily be included and destroyed; so that, according to this hypothesis, which has frequently been brought forward, the phagocytes play a purely secondary and dependent part, waiting until the microbes are weakened before they seize upon them. In favor of this view, the fact has been cited that certain micro-organisms cultivated in the blood, or serum, of vaccinated animals become attenuated, so that they no longer induce a fatal disease. The bacillus anthracis grown in the blood of vaccinated sheep no longer kills rabbits, and, according to Roger, the streptococcus erysipelatosus grown in the blood of vaccinated rabbits only occasions a slight and passing disturbance in susceptible members of the same species. But, here again, we are dealing with fluids withdrawn from the body, and so modified in various ways. Let us make an observation more strictly to the point: Take, for instance, a rabbit vaccinated against anthrax and inoculate it with anthrax bacilli, thus allowing these to exist directly within the refractory organism. Such bacilli as are not destroyed preserve their virulence for a sufficiently long period, and it is possible to kill a guinea-pig with a drop of exudation taken from the region of injection thirty hours after subcutaneous inoculation, eight days after inoculation into the anterior chamber of the eye. A sojourn of so long duration within the vaccinated organism, then, has not deprived the microbes of their virulence, although twenty-four hours suffices to completely attenuate the bacilli cultivated in the removed blood of vaccinated sheep.

Years ago, it was established in M. Pasteur's laboratory that the refractory organism, instead of being an unfavorable soil for the preservation of virulence, tends the rather to reinforce this property. To exalt the virulence of an attenuated micro-organism, one always employs, not animals very susceptible to the specific disease, but those which are slightly susceptible, or it may be, under many circumstances, refractory. In this manner the most active anthrax virus has usually been obtained by passage through birds, notably fowls; the greatest virulence of chicken cholera was gained by passage through the vaccinated cock, and quite recently M. Malm has shown that passage of the anthrax bacillus through the organisms of dogs, which of all mammals are the most refractory in this respect, increases its virulence in a most remarkable manner, so that the general law may be laid down that an organism which is but slightly susceptible or is refractory is able not only to preserve, but even to exalt, the virulence of bacteria. The principal argument in favor of the hypothesis, that pathogenic microorganisms become simple inoffensive saphrophytes when they find themselves in a refractory region, loses therefore its *raison d'etre*.

M. Bouchard, in his objection to the theory of phagocytosis, may be regarded as introducing but a modification of this hypothesis. He holds that pathogenic bacteria placed under favorable conditions give rise to substances which hinder the inflammatory process, and that only when these inhibitory substances are inadequately represented do the cells intervene. When, therefore, the organism rendered refractory by vaccination becomes an unfavorable soil for the production of these inhibitory bodies, the bacteria can no longer prevent the inflammatory reaction ; free emigration of the leucocytes ensues, these cells seize upon the impotent microbes, and put a stop to their further growth. In this theory, the part played by the phagocytes is again secondary, depending upon a dearth of anti-inflammatory substance.

If the theory could be accepted in certain cases, it is nevertheless inapplicable as a general rule. In all those affections which are characterized by the absence of leucocytes upon the field of battle there is certainly no lack of inflammation. The very reverse obtains. In anthrax affecting small mammals, just as in the vibrionic septicæmia of pigeons and guinea-pigs and other analogous diseases, we find that there is a very distinct dilatation of the vessels, accompanied by great exudation ; the inflammatory reaction is well marked, nothing is wanting save the determination of the white corpuscles. Or employing yet further that affection, which is, as it were, the touchstone of the bacteriologist, a still clearer proof of our contention is to be gained, if we inoculate a rabbit on the one ear with a small quantity of virulent, on the other with a like quantity of attenuated, anthrax virus. In the course of a few hours the external signs of inflammation are far more conspicuous in the former ; the vessels are greatly enlarged, and there is literally a huge exudation of clear serous fluid into the part; in the latter the external signs are less prominent, but examination of the seat of inoculation shows it to be packed with leucocytes. Consequently, the phenomenon we are discussing is to be explained not by an absence of the inflammatory process, but much more satisfactorily by a negative chemiotaxis of the leucocytes, which, instead of being attracted by the bacterial products, are repelled; where the animal is vaccinated or refractory a much slighter inflammation is sufficient to produce an abundant emigration of the leucocytes.

During the last few days Behring has brought forward another view which would explain immunity in a wholly different way. According to him the bacteria can live and even preserve their virulence in the refractory organism, but the *toxines* excreted by them now undergo a modification so as to be rendered completely inoffensive for the animal. And to this "toxicide property" of the organism is to be attributed the essential quality of the immune state. It is impossible to pronounce upon the arguments that have led up to this theory, for as yet they have not been circumstantially set forth, but already one can declare that such a theory is in no wise applicable to the phenomena of immunity in general. In three diseases remarkable for their pronounced toxic character—vibrionic septicæmia, pyocyanic disease, and hog cholera affecting the rabbit—as shown by the experiments of Charrin, Gamaleia and Selander the toxines are so little attacked by the refractory organism that the same quantity of these substances (freed from bacteria) suffices to kill an animal very susceptible to one or other disease, and an animal vaccinated against it and thus completely immune. So, too, non-fatal doses of these toxines produce in animals of the two categories the same febrile and inflammatory reactions. The proof is clear that there is no special destruction of toxines in the refractory animal, and that the "toxicide property," if it exists, is not one whit more developed after vaccination than before. Passing in review all these counter theories we see that each of them can only be applied to a certain number of facts; in some an attenuating or even bactericidal influence of the juices is relied upon, in others an anti-inflammatory action; in yet others a toxicide property. Still the phagocytic reaction is the only constant in all those cases of immunity and recovery that have as yet been sufficiently studied, and while certain of the factors mentioned (the attenuating and toxicide properties) do not in the least touch upon the continued existence or otherwise of the micro-organism, the bactericidal power of the phagocyte puts an end to the parasite itself, and thus at a given moment prevents further manifestation of its virulence, or preserves the animal attacked at a time when the toxicide properties would be found wanting, and the microbe remaining alive would consequently gain the upper hand.

But while thus placing before you the important part played by the phagocytes, I do not wish it to be thought that these cells are unaided in their contest by other defensive means possessed by the organism. This is far from being my view. Thus, in the febrile reaction, we see a puissant auxiliary very definitely favoring the work of the phagocytes. This febrile reaction has only to be inhibited—as was done by M. Pasteur in the anthrax of fowls—and animals naturally refractory to the affection succumb to the ravages of the bacilli. It is not possible at the present time to state fully and accurately all these influences which are associated in aiding phagocytic action, but already, we have the right to maintain that, *in the property of its amœboid cells to include and to destroy micro-organisms, the animal body possesses a formidable means of resistance and defense against these infectious agents.—The British Medical Journal.*

[THE END.]

THE NUMBER AND APPEARANCE OF TUBERCLE BACILLI IN THE SPUTUM AFTER TUBERCULIN INJECTIONS.

BY L. BREMER, M. D.

Before the St. Louis Medical Society.

I have brought with me to-night a specimen of tuberculous sputum for the inspection of the Society. The specimen has been prepared after Ziche's method, with carbolo-fuchsine. The sputum was handed to me for examination by Dr. Mulhall. It is obtained from a patient who is undergoing the Koch treatment.

Among the first published reports on the Koch method was one of Fraentzel, of Berlin, who claimed that the form of tubercle bacillus was materially changed by the tuberculin when introduced into the circulation. He asserted that after injection the bacilli lost much of the staining facilities ; that they became smaller and more slender, assumed the biscuit shape or that the rods were composed of a number of coccus-like formations.

If the sputum which I submit to your examination is an example of what Fraentzel saw and described,I must say that I have seen, time and again, like others, the same in the many sputum examinations which I have made since the day that Ehrlich's method was first published.

Some time ago, I received from a friend, one of the slides which were advertised and for sale in Berlin, showing the bacilli as they appear after tuberculin injections. The forms that I saw there were old acquaintances.

In the specimen which I have to-night placed under the microscope, some of the microbes show the forms which have been described as characteristic of tuberculin action.

They are present in immense numbers, so that the droplet of sputum, which was subjected to the staining process, may justly be said to have been a pure culture of tubercle bacilli, exhibiting various stages of a retrogressive metamorphosis.

To my mind, the explanation of this often observed fact is the following, viz. :

Nearly all observers argue that cough and expectoration increase after tuberculin injections. With increased cough, little round, whitish, more or less globular bodies, which are often formed in cancers, and which consist of almost pure cultures of the parasite, are expelled and are made accessible to microscopical examination. Iodide of potassium, which has of late been proposed instead of tuberculin by an investigator, for diagnostic purposes, will probably have the same effect.

Specimens like the one which I have prepared for your examination, I have often seen in ante-tuberculin days.—*St. Louis Medical and Surgical Journal.*

SCIENTIFIC GLEANINGS.

AMMONIACAL FERMENTATION OF URINE.

BY VERANUS A. MOORE, M. D.

[CONCLUDED.]

DESCRIPTION OF NEW GERMS.

In the light that we already have concerning this class of organisms and in the present unsettled condition of bacteriological classification, it seems more desirable to omit the assigning of specific names to the micrococci about to be described, but simply differentiate them with reference to their morphological characters and their growth in certain culture media. They will, therefore, be designated by the first letters of the alphabet, printed in small capitals, as *micrococcus* A. *mic.* B, etc. In comparing the morphological and cultural characters of these germs with the description of the micrococci described by Pasteur, Fluegge and Miquel I have failed to find sufficient resemblances to establish the identity of any of these micrococci with those heretofore described. Their effect upon urea in nutrient solutions is, however, practically the same.

MICROCOCCUS A.—A micrococcus varying in diameter from 0. 6 μ to 1. 2 μ; average, 0. 9 μ. When grown in bouillon the cocci appear most usually in small clumps and in the form of diplococci. There seems to be a marked disposition in the cocci to be closely united in pairs. In acid bouillon they are frequently observed united in short chains.

Agar (surface growth) at 96. 8° *F.*—After 24 hours round, convex, grayish colonies appear with a glistening surface and sharply defined border. When they are separated by a distance of one-half inch or more they are about 1 millimetre in diameter. After growing for several days the colonies become opaque, whitish, but otherwise unchanged in appearance. The colonies are quite brittle. The growth in the condensation water is quite vigorous, giving it a clouded appearance.

Gelatine (needle culture).—In nutrient gelatine the growth is quite vigorous at 70° F. Along the needle track, after 24 hours, a grayish, opaque, somewhat granular line appears, which consists of crowded colonies. At the surface the growth is more vigorous, forming an elevated glistening band around the needle puncture. This may be due to the greater number of germs collected there. On the second or third day the gelatine begins to liquefy along the entire length of the needle track. At first the liquefaction is generally more rapid on the surface, giving a cone-like appearance to the liquid portion, the base being at the surface (Pl. I, Fig. 1). Very often the liquefaction is in the form of a cylinder. The entire mass of a gelatine is liquefied in from 8 to 20 days. In a higher temperature (75° to 80° F.) the growth is more rapid. The liquid gelatine holds in suspension fine granular masses of germs 1-10 to 1-4 millimetre in diameter. A considerable quantity of a grayish sediment collects in the bottom of the tube ; also a fine granular pellicle forms over the surface. Both the pellicle and sediment are very viscid. The liquefied gelatine will not set, showing that it has become peptonized.

In alkaline bouillon the growth is very feeble, the liquid becoming barely clouded, even after several days' standing. In acid bouillon the growth is at first also feeble, but on the second day it is very much increased, the liquid is quite clouded, and a granular pellicle forms over the surface. The acid reaction is not appreciably changed In sterile milk at 96. 8° F. this germ coagulates the casein after about two weeks standing. It grows very vigorously. The reaction remains slightly acid. A slight sour-milk odor is emitted.

Sterile urine at 96. 8° *F.*—This germ multiplies very rapidly in this liquid. After 18 hours it becomes quite clouded with the formation of a grayish sediment. Its acid reaction is changed to a feebly alkaline one, which becomes very strong after 36 to 48 hours. The odor is penetrating, resembling that emitted by ammonia water. In acid bouillon plus urea at 96. 8° F. this germ grows very rapidly. After 24 hours the liquid is very clouded, with considerable sediment formed in the bottom of the tube. The reaction is changed to a strong alkaline one. A slight ammoniacal odor is emitted. In the acid gelatine plus urine the growth is more vigorous and the liquefaction more rapid than in the ordinary gelatine. With the liquefaction its reaction is changed to a strong alkaline one. The liquid gelatine becomes perfectly cleared, with a somewhat viscid sediment.

This germ is easily stained with the aniline dyes. It does not take the Gram stain.

MICROCOCCUS B.—A micrococcus varying from 1.0 μ to 1.8 μ in diameter; average, 1.4 μ. It occurs single, in pairs, and small clumps. It is occasionally seen in short chains, especially when grown on agar or gelatine.

Agar (surface growth) at 96.8° F.—The growth of this germ on agar resembles in its general appearance that of the micrococcus A. It differs from that germ in two respects: (1) The growth on the surface is very viscid. (2) The condensation water remains clear, with a grayish, somewhat viscid growth at the bottom.

Gelatine (needle culture) at 75° F.—After 24 hours a grayish granular line appears along the needle track. At the surface the growth is more vigorous, spreading and liquefying the gelatine in a thin layer over the entire surface. The growth along the needle track does not increase, but the gelatine gradually liquefies from the surface downward until from one-half to two-thirds of the gelatine has become liquid. The liquefaction does not extend beyond that point (Pl. I, Fig. 2). A more or less thick, whitish membrane forms over the central portion of the surface, rarely forming a complete pellicle. A layer of grayish, viscid growth forms over the surface of the non-liquefied gelatine. The liquid portion holds in suspension grayish granules, which are occasionally so fine as to give a uniform clouded appearance to the liquid gelatine. The liquefaction is completed in from one to two weeks.

In bouillon at 96.8° F. the growth is very feeble. After 24 hours the liquid is very faintly clouded. In from two to four days a somewhat stringy growth appears in the upper part of the liquid; also granular masses, varying from 1 to 2 millimetres in diameter. These are quite viscid. In acid bouillon, after several days a few granular masses are formed on the surface; also a whitish deposit on the sides of the tube at the surface of the liquid.

In sterile milk this germ, after about two weeks, coagulates the casein, leaving a clear supernatant liquid.

Sterile urine at 96.8° F.—This germ grows rather freely in urine. After 24 hours the liquid is very faintly clouded and neutral in reaction. After 48 hours it is strongly alkaline and clouded with the formation of a small quantity of sediment. In acid bouillon plus urea the growth is not vigorous. After 24 hours the reaction is feebly alkaline. At the end of two to three days the reaction is strongly alkaline and the liquid quite cloudy—a slight penetrating odor. In acid gelatine containing urea the growth is more vigorous than in the ordinary gelatine. The liquefied gelatine is strongly alkaline in reaction.

This germ is easily stained with the aniline dyes. It takes the Gram stain.

MICROCOCCUS C.—A micrococcus varying in diameter from 0 8 μ to 1.5 μ; average, 1.2 μ. It occurs single, in short chains, and small clumps. There are also diplococci forms.

Agar (surface growth) at 96.8° *F.*—On this medium the growth does not differ appreciably from that of micrococcus A.

Gelatine.—This germ liquefies gelatine very slightly, so that the growth, which at first is upon the surface, after several days becomes slightly depressed, never more than one to two millimetres. The growth along the needle puncture is whitish, opaque, viscid, and quite thick. The colonies along the needle track are very small. They do not liquefy the gelatine (Pl. I, Fig. 3).

In bouillon the growth is very feeble; after 24 hours the liquid becomes faintly and uniformly clouded. There is no further development. Sterile milk inoculated with this germ and kept at a temperature of 96.8° F, becomes thickened in the lower half of the tube after about six days. There is no separation of the casein from the aqueous portion; no odor; slight acid reaction.

Sterile urine.—In this liquid the growth is feeble. On the day following its inoculation the reaction is faintly alkaline, the liquid barely clouded. On the third day there is a thin granular deposit on the sides of the tube, and the reaction is strongly alkaline, ammoniacal odor. In acid bouillon plus urea at 96.8° F. the liquid becomes clouded on the day following the inoculation, with the formation of a considerable quantity of sediment; strong alkaline reaction, penetrating odor. After ten days' standing it becomes clear, with a sediment. It remains strongly alkaline. In acid gelatine plus urea the growth is very feeble; no liquefaction.

It is easily stained by the ordinary methods. When stained according to Gram a great majority of the cocci take the brown stain perfectly. A few (about one in fifteen) retain the blue stain. These are of the maximum size (1.5 μ).

MICROCOCCUS D.—A micrococcus varying in diameter from 0.7 μ to 1.2 μ; average, 0.9μ. It grows mostly usually in small clumps and in pairs. It is very rarely seen single.

Agar (surface growth) at 96.8° *F.*—When not crowded the isolated colonies, after 24 hours, are from 1 to 1 1-2 millimetres in diameter, round, flat, with a smooth border and sharply defined margin; a considerable growth in the condensation water. The colonies at first are grayish white, glistening, but after several days they become a light cadmium yellow. The size is very slightly increased. When grown on agar containing 5 per cent. glycerine the growth is more feeble, but the color more intense.

Gelatine (needle cultures).—Along the needle track the colonies develop after 24 hours as minute grayish points. After several days they attain to a diameter of 1-8 to 1-4 millimetre, spherical, granular, yellowish. On the surface the growth is spreading, glistening, of a deep cadmium yellow. The growth about the needle puncture appears in more or less concentric bands. The outer bands also have a radiating appearance, produced by alternate lighter and darker lines extending outward from the more central portion. After about two weeks the growth becomes slightly depressed below the surface (Pl. I, Fig. 4).

In bouillon the growth is feeble. After 48 hours, 96.8° F. the liquid becomes clouded in the upper portion of the tube, with a small quantity of a grayish deposit formed on the side of the tube. It produces no change in the appearance of milk.

Sterile urine.—In this liquid the growth is abundant; the liquid is heavily clouded after 24 hours; the reactions strongly alkaline. After from two to three days a considerable quantity of sediment is formed in the bottom of the tube. This germ is the most rapid in its transformation of acid into alkaline urine of any of the germs here described. Under its influence acid urine will become decidedly alkaline in eighteen hours. In acid bouillon containing urea the growth is vigorous. In 24 hours the liquid is very cloudy and strongly alkaline in reaction. In acid gelatine plus urea the growth is more feeble than on the ordinary gelatine. It takes the Gram stain.

MICROCOCCUS E.—A micrococcus varying from 0.9 μ to 1.5 μ in diameter; average, 1.2 μ. It occurs most usually in small clumps and in pairs. It is frequently found single, often in short chains.

Agar (surface growth) at 96.8° *F.*—After 25 hours quite fleshy, round, convex colonies appear, 1 millimetre in diameter when not crowded. They are of a grayish yellow color, opaque. After several days the growth becomes a much deeper yellow. The condensation water is clear, with a viscid, flaky growth at the bottom. The surface growth is not viscid.

Gelatine.—The growth in this medium resembles that of the micrococcus B. It differs from it in the color of the membrane and sediment, which are cadmium yellow (Pl. I, Fig. 5).

In bouillon the growth is feeble. It does not produce any apparent change in the appearance of milk.

Sterile urine.—The growth in this liquid is very slow. On the second day after inoculation it becomes feebly alkaline, with the formation of a granular deposit on the sides of the tube. In acid bouillon containing urea the growth is more vigorous. After one day, at 96.8° F. the reaction becomes strongly alkaline, emitting a penetrating odor. It liquefies acid gelatine containing urea very slowly. The liquefaction does not extend more than three to five millimetres below the surface. The liquid gelatine is strongly alkaline in reaction. This germ is readily stained by the ordinary methods. It takes the Gram stain.

The characteristic properties of these micrococci, especially their reaction on nutrient gelatine, are more or less modified by cultivation. Their power to break up urea, however, does not seem to be diminished.

I have examined, after the methods previously described, twelve specimens of urine. Of these, seven contained only the micrococcus A, two the micrococcus C, one the micrococci A and B, one the micrococci B and D, and one the micrococci A, C and E. Eight of the specimens were taken from the same individual, six of which contained (of the germs described) the micrococcus A only, and two the micrococcus C. The other four specimens were obtained from four other individuals, one of which contained only the micrococcus A.

In addition to the above, one specimen of urine from a person suffering with cystitis was examined. The urine was clouded, strongly alkaline in reaction, and contained a considerable quantity of crystals, principally triple phosphates, pus cells and amorphous salts. A large number of micrococci were seen in a cover-glass preparation. The bacteriological examination showed that a large number of these were the micrococcus A. Thus far this is the only specimen of urine from an authentic case of cystitis that I have been able to obtain in a condition suitable for a bacteriological examination.

I have also isolated several germs from external sources that are equally as active in the production of ammoniacal fermentation as those already described. Two of these, a bacillus and micrococcus, were obtained from decomposed urine that was previously sterilized and then exposed to the atmosphere of the laboratory by removing the cotton wool stoppers from the tubes containing it. The sterile, acid urine became clouded and alkaline in from three to five days. A second bacillus was obtained by inoculating a tube of sterile urine with several drops (about 1 cc.) of Potomac water and allowing it to stand in an incubator, where it became clouded and alkaline in twenty-four hours. The bacillus was isolated from the other germs by means of plate cultures. A micrococcus was also found in saliva which is arranged in fours (tetracoccus), that is very active in transforming urea into carbonate of ammonia. These germs have, as yet, not been carefully studied, and their isolation is mentioned here only to illustrate the general distribution of bacteria possessing this property, as well as to confirm similar statements made by other workers in this line.

SOLUBLE FERMENTS.

In the last decade Musculus (9) announced the discovery of a soluble ferment which he obtained from ammoniacal urine that would, when introduced into fresh urine, transform its urea into carbonate of ammonia. The name *urase* was proposed for this substance, as it was supposed to belong to the same class of ferments as ptyalin diastase, etc. The method of isolating this ferment was reported by Musculus to be one of simple precipitation. The results, however, that have been reported by others who have attempted to isolate this substance, have been, so far as I can learn, negative in character. P. Miquel, after a long series of experiments, in many of which the method of Musculus was carefully carried out, concludes with Prof. Leube, that the existence of a soluble ferment in urine is not sufficiently proven to be accepted without further demonstration. Thus far I have made no experiments for the purpose of isolating a soluble ferment. Whether there is such a ferment or not will, together with many other interesting questions that these preliminary investigations have suggested, have to remain unanswered until other and more extended investigations shall be made.

PLATE I.

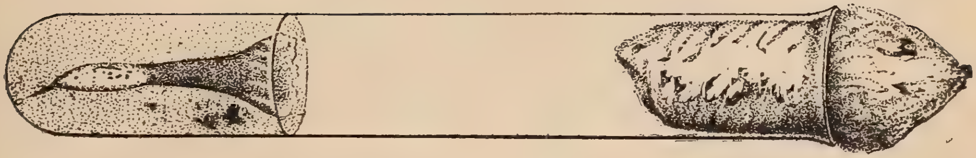

FIG. 1.

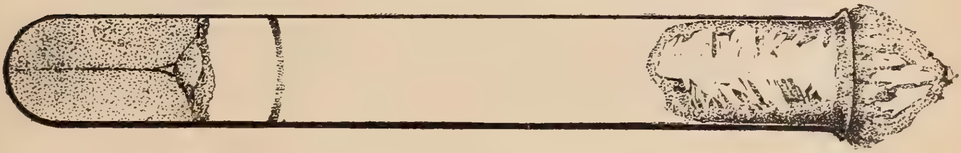

FIG. 2.

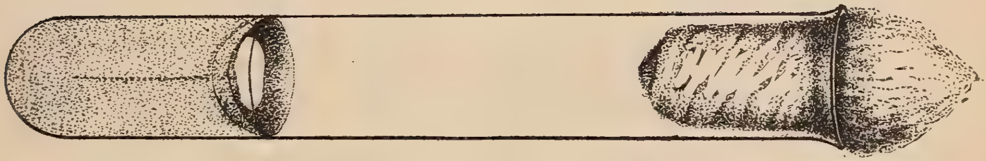

FIG. 3.

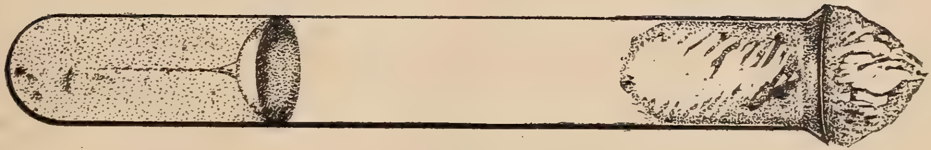

FIG. 4.

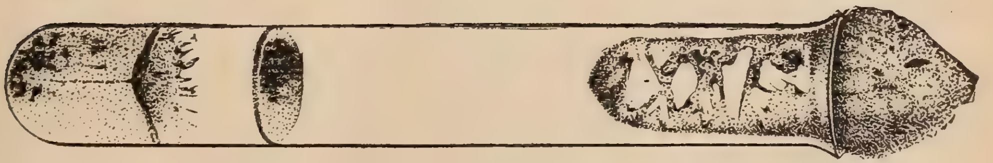

FIG. 5.

DESCRIPTION OF PLATES.

Plate I.

Gelatine needle cultures of the micrococci described.

Fig. 1, Micrococcus A—Culture seven days old.
" 2, " B " " "
" 3, " C " six weeks old.
" 4, " D " " "
" 5, " E " " "

Plate II.

Drawings made from cover-glass preparations of urine cultures, one day old, of the micrococci described. The preparations were dried, passed three times through a flame, and stained for a short time with alkaline-methylene-blue. The position of the germs in the field was determined by means of Abbe's camera lucida, Zeiss 2 mm. apochromatic lens, No. 4 eye-piece.

Fig. 1, Micrococcus A.
" 2, " B.
" 3, " C.
" 4, " D.
" 5, " E.

PLATE II.

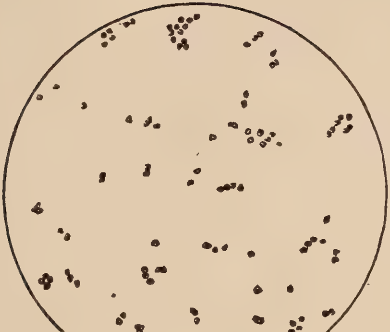

Fig. 1

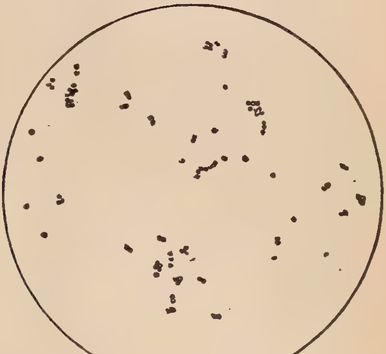

Fig. 2

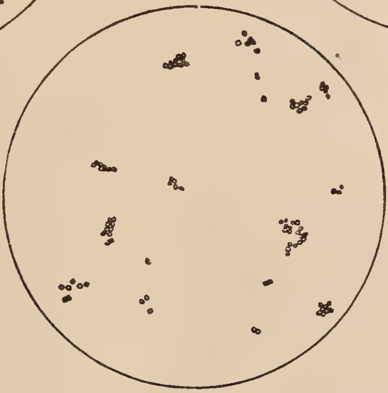

Fig. 3.

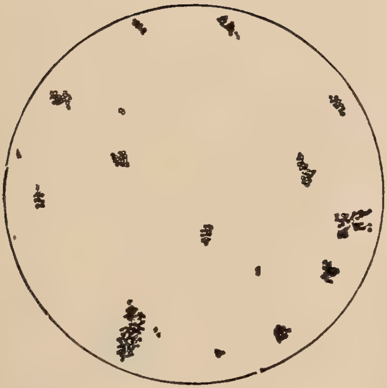

Fig. 4

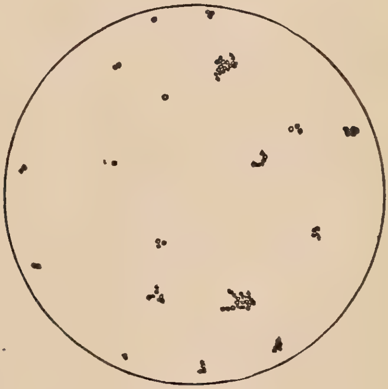

Fig. 5

Haines, Del.

Proceedings of the American Society of Microscopists.

THE ETIOLOGY OF TETANUS.

In the last number of the *Annales de l' Institut Pasteur*, there appears (from the Bacteriological Laboratory of Val-de-Grace) a most interesting paper on tetanus, by Drs. Vaillard and Vincent, which appears to throw very considerable light on the subject of tetanus, and to clear up a number of points and observations that have hitherto been enshrouded in obscurity. After describing the organism, and identifying it with that already made familiar through the papers of recent writers, the authors give it as their firm opinion that, in cases of artificial inoculation of pure culture, it is always the poison introduced along with the bacillus, and not the organism itself, that acts upon the animal. This, indeed, seems to be probable, as they are able to prove that almost inconceivably minute doses of this poison, which they compare with snake poison, are quite sufficient to produce all the symptoms of most acute tetanus ; in fact, it was almost impossible, from some of the cultures that they obtained, to administer a dose that was not lethal.

An exceedingly interesting feature brought out in the course of their work is that in no case was the poison developed as soon as the organism began to grow ; in fact, gelatine cultures of the tetanus bacillus were never capable of producing toxic symptoms, until liquefaction of the gelatine had commenced, when spores were demonstrated to have been formed, and when the peculiarly disagreeable odor, so characteristic of tetanus cultures, had become perceptible. They associate both the odor and the peptonizing power with the formation of the poison in the cultures. That it was due merely to the presence of the spores that the material was poisonous, they demonstrated by heating their cultures to a temperature of 143.6° F. for a short time (a temperature which is quite incapable of interfering with the vitality of the spores), when it was found that cultures so heated and introduced by inoculation into a rabbit, or a guinea-pig, failed to produce any tetanus ; thus proving that, although the spores are not killed, the poison has been destroyed by the heat. The spores were proved to be living, by making fresh cultures from them in artificial media ; after a time they grew luxuriantly, and, if left to grow eight or ten days, produced another crop of the poison. By simply washing away the poison from the spores with distilled water, they also obtained similar results, for, although the spores could still develop and form the specific poison in artificial media, they were, when inoculated, incapable of giving rise to any symptoms of tetanus. From the reaction to heat of a substance they were able to separate, and from its resemblance to the diastases in other respects, they conclude that they have obtained from tetanus cultures the true tetanus poison—a poison, however, that cannot be formed by the tetanus bacillus in healthy tissues. The micro-organisms are here so rapidly attacked by the leucocytes that they are rendered *hors de combat* before they have time to form their poison.

It has long been well known that the tetanus bacillus could not develop in the tissues except, apparently, in the presence of other organisms, and the suggestion is offered, that these other organisms act in one of two ways: they either paralyze the activity of the leucocytes, or they draw off, as it were, their attention and activity from the tetanus bacillus, thus allowing it sufficient time to develop its characteristic products. It is interesting to note that Drs. Vaillard and Vincent consider that, in many respects, the tetanus bacillus is extremely like the diphtheria bacillus—the method of action on and in the organism being essentially the same in the two cases, the above factors. in all probability, playing a part in diphtheria, much as in the case of tetanus; and it is evident that, in studying the one poison, much light may be thrown on the other. Behring and Kitasato appreciated this fact, and combined their forces to work out the question of immunity in these two diseases. It is obvious, however, from a consideration of some of the points that are indicated in this paper, that there are many sources of fallacy that will have to be eliminated before the ultimate explanation of the condition of immunity in protected animals can be given. The facts that this poison is active in such extraordinary minute quantities, and that the micro-organisms are able to grow with such difficulty in the human tissues, allow us to hope that extremely minute changes in the blood may be quite sufficient to secure the alteration or breaking down of the virulent poison, even when it has become diffused throughout the system. So long as the organism is localized to the wound, there is, of course, more chance of coping successfully with the disease, although here, as in other diseases, there always appears to be a possibility of the poison exerting such a paralyzing influence on the cells that usually take up foreign substances, that secondary septic conditions may be liable to occur, even when the action of the tetanic poison can be antagonized so far as its primary effects on the cells are concerned. One question appears to be set at rest, and that is, as regards tetanus and diphtheria, the ptomaines have had their day, whatever may become of the products of other organisms. It may be accepted that here, at any rate, we have some subtle poison, which, although it has not yet been actually separated, has become so far isolated that it may be taken as proved, that it is not an alkaloid or basic poison. A most remarkable feature is, that, in peptonizing gelatine with the filtrate from a meat-broth culture of the tetanus bacillus, the poisonous properties are lost, to a certain degree, in direct proportion to the amount of gelatine that is peptonized; this, taken in conjunction with the fact that the properties are not developed until the gelatine begins to liquefy, has led Drs. Vaillard and Vincent to suppose that the same agent that peptonizes the gelatine, is the active agent in bringing about the development of the toxic symptoms of tetanus.—*The Lancet.*

THE REPUTED CAUSE OF INFLUENZA.

Dr. Tezzier, of Lyons, France, claims that influenza is produced by a microbe, which he styles the strepto bacillus, whose habitat is putrid mud. That Russia is its home, is, in his opinion, due to the fact that bad drainage, filthy streets, and neglected barnyards are the rule—a condition particularly aggravated by swollen rivers and generally wide plains.—*Medical and Surgical Reporter.*

LUMINOUS MICROBES.

Revue Scientifique, Paris, April 18.

Mr. W. Beyerinck, whose interesting researches have already largely contributed to an acquaintance with the biology of luminous microbes, has continued his studies of them. In an important memoir, just published in the *Archives Neerlandaises des Sciences Exactes et Naturalles,* he undertakes to show what are the elementary substances necessary for the activity of the light-giving function in the known luminous species.

There are five species of light-giving microbes. First, there are the common luminous bacteria of the phosphorescent fish. Of these there are two species. Of the two the most luminous is the *photobacterium pfluegeri,* which is also the most luminous microbe known ; the other is the *photobacterium phosphorescens,* of which the light is not so strong. From a morphological point of view *ph. phosphorescens* has a form more or less spheroidal or oblong. The *pfluegeri* is longer. The luminous bacteria of the Baltic are found in two varieties of one species ; the *photobacterium fischeri* which liquefies gelatine, and the *ph. fischeri F. baltica,* which does not liquefy gelatine. This is really the sole difference between the two varieties. Two allied species—completing the number of five—are the *ph. indicum* of the West Indian seas, and the *ph. luminosum* of the North Sea. These two species quickly liquefy gelatine.

The luminous power of *ph. indicum* is great, and in that respect it ranks next to *ph. phosphorescens.* Like all the luminous bacteria, *ph. luminosum* and *ph. indicum* are extremely sensitive to the presence of small quantities of sugar in their aliment. One per cent. of glucose or even less will completely extinguish the light-giving power of the *luminosum,* which with from three to five per cent. of glucose becomes incapable of liquefying gelatine, while larger doses kill it. The *ph. indicum* is a little less sensitive to glucose. It still continues to give light after the addition of four per cent. of glucose ; but under these conditions it takes on involved forms.

M. Beyerinck gives the name *auxanographie* to the method which he employs to prove the influence of this or that alimentary substance upon the different functions of microbes.

According to him the light-giving function, in the luminous bacteria, as in all the luminous creatures of the organic world, exists in living matter only. He has never succeeded in isolating any luminous element or in making any light-giving matter become luminous, except in living cells. Mr. Radzizewsky, however, is of a different opinion and likens organic phosphorescence to chemical phosphorescence, produced by the combination of certain chemical substances.

A question put by Mr. Beyerinck is whether, in the struggle for existence, microbes derive any advantage from their light-giving function. He answers this question in the negative. Observation so far does not warrant us in believing that the light emitted by microbes is in any way useful to those organisms. The light seems to be the accidental consequence of chemical transformations; and this conclusion is corroborated by the fact that *ph. luminosum,* for example, is much easier to obtain and preserve in a non-luminous than in a phosphorescent condition. This microbe becomes luminous only at a low temperature towards 15° 6 min. On the contrary, it is killed by insufficient nourishment and a temperature too low; and it is in this condition that it is commonly found on the seashore. Other bacteria, *ph. pfluegeri* and *phosphorescens* are, it is true, less delicate. Nevertheless, when their carbonized aliment is very insufficient, their luminous power completely disappears, so that in realty, these microbes pass the greater part of the year, in the sea and on the shore, without emitting any light.

With the researches of Mr. Beyerinck on the light-producing alimentation of luminous microbes, should be noticed the recent labors of Mr. C. Gessard as to the influence of the nature and composition of nutritive matter upon the production of the pigments of the *bacillus pyocyanique,* the microbe which secretes a blue and green coloring matter. The production of the pigments is similar, in many respects, to the production of light. Both are produced under the condition of good alimentation and good health in the microbes, and testify to the appearance, under proper conditions, of a function, which of late years has been happily styled the function of luxury—since, in fact, this function, distinct from nutrition and multiplication, is indispensable neither to the life nor to the reproduction of micro-organisms.

Mr. Gessard has discovered that the *bacillus pyocyanic*, in order to manufacture the two pigments which characterize it when in good health, has need of a special medium, the ordinary *bouillon* of cultures in the laboratory. Upon the albumen of an egg, the green pigment alone appears. This last does not appear in mediums formed of peptin and gelatine. Also it has been discovered that the addition to the nourishment of glucose, which kills the luminous microbes, stops the production of the blue pigment characteristic of the pyocyanic bacillus.

Moreover, as yet we know only vaguely what it is that makes microbes dangerous to human life ; but the most recent researches seem to agree in attributing this terrifying quality of microbes simply to an aptitude to multiply and reproduce themselves. This dangerous quality of microbes appears to depend, however, on the quantity and quality of poisonous substances which it secretes, and this poison-producing function is also a very delicate function of luxury and dependent solely on favorable conditions, which it is sometimes very difficult to unite. There are, then, in microbes, three functions, very nearly related to each other ; these are the light-producing, the color-producing, and the poison-producing. Light, color and poison are three functions superadded to the indispensable functions of life, and which appear to be dependent on conditions which, if not identical are at least nearly related to each other from a general point of view. The study of one of these functions may help acquaintance with the others ; and if we can manage to understand thoroughly the conditions under which poison-producing microbes exercise their peculiar function, we shall soon be able to stop the exercise of that function ; that is to say, we shall soon be able to cure the infectious maladies. —*Literary Digest.*

CHEMICAL REACTIONS OF KOCH'S TUBERCULIN.

In the *Farmatzevtitchesky Juernal*, No. 9, 1891, p. 136, Mr. I. Gertel, a chemist, publishes the result of his examination of a specimen of Koch's "tuberculin." The "lymph" forms a cinnamon-brown, odorless, viscid fluid, sp. gravity of 1.17 and of a neutral reaction. Concentrated sulphuric acid dissolves it easily and completely, the solution being at first colorless, but after a while assuming a cinnamon-brown color. Concentrated hydrochloric acid does not manifest any action on the lymph, while concentrated nitric acid produces a slight opacity, appearing at the point of contact between the two fluids. When immersed in a sulphuric acid solution of tuberculin, crystals of bichromate of potassium soon become covered with bubbles (which are due to glycerine being present in the preparation). The following reagents give considerable precipitates on being added to a 10 per cent. aqueous solution of tuberculin : Tannic acid, picric acid, chloride of gold, nitrate of silver, sulphate of copper, nitrate of mercuric suboxide ; but chloride of platinum, neutral acetate of lead, and chloride of tin, produce a comparatively slight precipitation ; iodide of potassium and cadmium (double salt) give a distinct turbidity, but no actual deposit. The following substances behave entirely negatively toward the solution : Iodide of potassium and mercury (double salt), bi-iodide of potassium, chloride of iron, ferro-cyanide of potassium, chloride of mercury, molibdenate of ammonia, rhodanide of potassium, chromate of potassium, ammonia, and sulphate of iron. When heated with acids, the aqueous solution assumes an intense yellow color. Strongly diluted aqueous solutions give voluminous precipitates with alcohol, the deposits being redissolved on a free addition of water. A 10 per cent. aqueous solution, as well as more diluted ones, when kept at the ordinary room temperature, becomes turbid even on the next day. As to the lymph itself (that is, an undiluted preparation), it has not undergone any changes even after four months' keeping.—*Medical and Surgical Reporter*.

SUMMARY OF THE RIPENING OF CREAM.

BY H. W. CONN, PH. D.

The most important points brought out in the present article are the following :

The ripening of cream is a process produced by bacteria growth. This is shown by the immense number of bacteria in the cream, and their almost incredible multiplication during the ripening process, and by the fact that all conditions which hasten bacteria growth also hasten the ripening process.

The variety of bacteria which are found growing rapidly in ripening cream is very great, and there is no uniformity in regard to species. Hardly two specimens of cream in the same creamery are ripened by the same variety of bacteria. The conditions affecting the growth of different species of bacteria are entirely beyond the control of the butter maker, and it is impossible to obtain uniformity of results by the ordinary methods of ripening. This fact is doubtless the cause of the occurrence of butter of inferior quality at certain seasons, and is one of the causes of difference between the butter of different creameries and dairies.

The bacteria which ordinarily ripen cream produce three classes of effects upon it during their growth. Some of them produce lactic acid, or small quantities of other acids. Some of them produce a rennet-like ferment which tends to precipitate the casein, and also a trypsin-like ferment which digests or peptonizes the proteid matters present. Some of them produce no effect beyond a slight decomposition and the possible evolution of volatile products. All of them assist in giving the peculiar flavor to the cream, and therefore probably the aroma to the butter. Perhaps a satisfactory aroma can be obtained by the use of single species if carefully selected.

No especially characteristic species have been found connected with the ripening process, The acid-forming species are, however, the most uniformly present in great numbers, and these are probaby the most intimately associated with the ripening.—*Storr's School Experiment Station Report,* 1890-1891.

THE MICROCOCCUS OF BITTER MILK.

BY H. W. CONN, PH. D.

* * * *

The organism which I have found in the specimen of bitter cream is undoubtedly a different one from that found by Weigmann. The following is a description of its characters :

Morphology.—It is a good-sized micrococcus which has no tendency to form chains. Occasionally two may cling together, producing diplococci. This is especially the case in gelatine and milk cultures. In agar it becomes longer, and rods are found several times as long as broad, which I have not been able to break up into cocci.

Mobility.—Not mobile.

Relation to the Air—Aerobic.—Under a mica plate it grows very slowly, giving rise to bubbles of gas, and the liquefaction of the gelatine takes place slowly. No such bubbles are produced where the plate is not covered with mica, and liquefaction is rapid.

Color.—White.

Colony on Gelatine.—Under the surface the colony is smooth and round. As it approaches the surface it becomes almost immediately diffused over the gelatine into a fine, thin granular mass, which spreads rapidly. There is no definite shape to the colonies after this.

Gelatine Stab Culture.—At first a very shallow pit is formed, but this spreads into a uniform layer of liquefying gelatine, which slowly deepens until the whole is liquefied. The resulting liquid is very slimy.

Agar-Agar.—A white glistening uniform growth.

Potato.—A white mass of more or less discrete bunches, glistening and moist; color of the potato not changed.

Milk.—Curdled in one day in a warm oven. Becomes very bitter. The litmus solution which is added to the milk turns slightly red. Later the color of the litmus is bleached. The curd which is formed soon begins to dissolve, though the solution is never quite complete. The liquid thus formed is slimy.

Bouillon.—Growth abundant. A thin membrane forms on the surface. The bouillon becomes remarkably slimy, and can be drawn out into threads ten feet long. Odor and taste like that of bitter milk.

The most remarkable feature of this organism is the power of rendering bouillon and gelatine slimy. The tenacity of the slime is hardly credible. The mass can be sometimes drawn out into threads ten feet long and no larger than a thread of silk, so as to be hardly visible. Curiously enough, though both bouillon and gelatine are thus rendered slimy, the sliminess does not at first appear in milk. After the digestion of the curd has taken place the liquid becomes slimy, but no slimy milk proper is formed; so this organism is, therefore, not one of those which produce the well-known slimy milk.

The taste produced in the milk is extremely bitter. It is not exactly like that of the original bitter cream from which the organism was obtained. This is due, however, to the fact that other organisms were present in the cream. I found that if a lot of sterilized milk was inoculated with the bitter organism and at the same time with one of the lactic acid-forming species, the taste is almost exactly that of the original cream.

This organism undoubtedly produced a chemical ferment or enzyme, with action similar to that of rennet.

* * * * * * *

A PIGMENT-PRODUCING BACTERIUM.

At a recent meeting of the Amsterdam Royal Academy of Sciences Beyerinck read a paper on the life history of a pigment bacterium. This organism, bacillus cyaneo-fuscus, is the cause of a much-feared local coloring process in Dutch cheese; called "blue illness"; and of "black glue," a calamity observed in a gelatin factory. The natural habitat of the organism is ditch-water and ground-water. It is a peptone bacterium, *i. e.*, it can be fed with albuminous matter alone. Hence a one-half per cent. solution of peptone in water is sufficient nutriment; gelatin, egg albumen, fibrin and casein are also, each alone, sufficient, but they are peptonized by a secretion of the bacterium, before absorption. The bacterium produces two pigments—one, deep blue spherites; the second, a dark brown diffusible coloring-matter. On this account a peptone solution acted upon by the organism becomes quite black.—*Exchange.*

AN ALKALOID FROM TUBERCLE BACILLI.

Zuelzer, the discoverer of sepsin, announces (*Berl. Klin. Woch.*) that, by a very simple method, he has succeeded in separating a ptomaine from the metabolic products of tubercle bacilli. For this purpose the entire contents of culture-tubes were repeatedily extracted by means of hot water acidified with hydrochloric acid, filtered, evaporated, decomposed several times with sulphuretted hydrogen, again filtered, and finally dried. In this way was obtained an almost white crystallized salt, easily soluble in hot water (104° F.), but not in cold. The solution had a slight yellow tinge. The dried salt, when kept for some time, turned to a clear brown. Its toxic effects upon rabbits and guinea-pigs were strongly marked and very characteristic.—*Druggists' Circular.*

VACCINATION AS A PREVENTIVE OF INFLUENZA.

Dr. Goldschmidt of Madeira hopes to conquer influenza by means of animal lymph, as re-vaccination against small-pox seems to confer almost perfect immunity from influenza. In consequence of the neglect of vaccination small-pox prevails frequently in Madeira, and not long ago it carried off more than a thousand victims. The doctor went in for re vaccination, and now finds that not one patient out of one hundred and twelve successful cases suffered from influenza, and out of ninety-eight successfully vaccinated, only fifteen persons were seized by influenza, and these in each case but very slightly. Recently vaccinated infants did not catch the influenza. It therefore appears to follow that re-vaccination gives effective protection, not only against small-pox, but also against influenza.

EXAMINATION OF INFUSORIA.

Every disciple of the microscope knows the difficulty of observing accurately these lively denizens of the water. If a drop of thick water solution of cherry gum be put into the live-cage, it has the effect of retarding the movements of the creature without materially affecting the ciliary motion.

EXAMINATION OF DRINKING WATER.

The water should be filtered through a short column of fine sand in the stem of a funnel, the sand being supported on a plug of wire-cloth placed beneath it. The sand retains the whole of the organisms contained in the water. The sand is then washed with distilled water, both being allowed to run into a test-tube. The mixed sand and water, after being shaken, must be left for the sand to sink, leaving the organisms suspended in the water. A definite quantity of this can be taken out by a pipette and the organisms enumerated.—*International Journal of Microscopy & Natural Sciences.*

MISCELLANEOUS.

BACTERIOLOGICAL INVESTIGATIONS CONCERNING THE ETIOLOGY OF PNEUMONIA IN CHILDREN.

Neumann (*Rev. Mens. des Mal. de l' Enf.*, July, 1890) says:

"Bacterial investigations in a number of cases of pneumonia in children led the author to the conclusion that the pneumococcus of Fraenkel is the unvarying cause of fibrinous pneumonia in children, the same as it is in adults. The same organism is also to be found in most of the cases of broncho-pneumonia in children. In sixteen cases of broncho-pneumonia, nine of which were consecutive to measles, the pneumococcus was found ten times. It is often very difficult to find the pneumococcus in broncho-pneumonia on account of its frequent association with other micro-organisms, including the streptococcus aureus et albus, streptococcus pyogenes, proteus vulgaris, and bacillus pyocyaneus. If the pneumococcus is not found, one must remember that it was present at the beginning of the disease, but has become attenuated, and has disappeared as the disease has progressed. The presence of an organism is an evidence of the existence of pneumonia, but the absence of the organism does not necessarily indicate that pneumonia is not present. Prophylaxis against pneumonic infection should be carried out by means of thorough ventilation and cleanliness of the apartments occupied by children with pneumonia, also by disinfection of the buccal cavity, and calling attention to the danger residing in the sputa of patients with pneumonia."—*Arch. Pediatrics.—Cin. Lancet Clinic.*

TECHNIQUE.

NEW AND RAPID METHOD OF STAINING THE CAPSULE OF BACILLUS PNEUMONIÆ.—Dr. U. Gabbi employs the following method for staining the capsule of *bacillus pneumoniæ* Frænkel. The sputum to be examined is spread upon a cover-glass and quickly dried in a spirit lamp flame. Two or three drops of a solution of 2.5 grams carbolic acid, 1 gram fuchsin, and 15 grams alcohol, in 100 grams distilled water, are then dropped on the preparation, where they are allowed to remain for one minute. It is then quickly washed in water, and in preparations thus treated the bacillus is stained dark red and its capsule bright red. The staining of the capsule vanishes if left too long in the water.—*Journal of the Royal Microscopical Society.*—*Microscopic Bulletin.*

"AIR-GAS" FOR BACTERIOLOGICAL WORK.— Dr. O. Katz, who had to work on Rodd Island, N. S. Wales, where the ordinary appliances of civilization were not available, made use of the "Alpha patent gas-making machine." This apparatus produces gas in the shape of a mixture of atmospheric air and the vapor of petroleum spirit (gasoline), the mixture being called air-gas. By means of weights atmospheric air is pumped through a drum into a chamber, where it is impregnated with the vapor of the volatile fluid. The mixture then passes into a gasometer, from which the burners are supplied automatically. The author used a 40-light machine, capable of yielding 200 feet of gas an hour.

The author considers that air-gas makes an efficient substitute for coal-gas for ordinary lighting purposes, and he also used it with success for heating thermostats, and also for other bacteriological purposes.—*Journal Royal Microscopical Society.*

NEGATIVE INDOL–REACTION AS A TEST FOR THE TYPHOID BACILLUS.—The resemblance, from their morphological and cultivation aspects, of numerous bacilli to the bacillus of typhoid, suggests the importance of having some specific test which may be easily applied in making a differential diagnosis between the bacillus of typhoid and other bacteria.

Recent observations have shown that potato cultivations do not afford a certain criterion; but after experimenting with sixteen kinds of bacteria, Dr. S. Kitasato found that these, when cultivated in bouillon, produced indol, while the typhoid bacillus did not.

The indol was tested for by Salkowski's method, that is, by treating the cultivations with a solution of nitrate of potash, and then adding a few drops of strong sulphuric acid. With this test the typhoid bacillus remained colorless, while the other sixteen bacilli assumed the characteristic red hue.

Careful chemical analysis also constantly showed the absence of indol from the typhoid cultivations.

As all these pseudo-typhoid bacilli developed on potato quite differently from the real typhoid bacillus, the author concludes that the negative indol reaction is in itself no better test than the growth on potato is.—*Journal of the Royal Microscopical Society.*

ON BACTERIOLOGICAL EXAMINATION OF THE SPUTA.—As is well known, all methods of a bacteriological examination of the sputa, as yet proposed, are applicable only to a newly expectorated discharge, and not to one of old standing. The inconvenience arising from the circumstance, for a busy practitioner (especially for a country one), being very considerable, Dr. Wikhail V. Savelieff, of Zemlansk, draws attention (*Meditcinskoie Obozrenie,* No. 21, 1890, p. 835), to a simple method for preserving the sputa, and examining it bacteriologically, at a more or less remote date after its expectoration. The author makes the patient expectorate directly into a vessel containing 95 per cent. alcohol, in which medium the discharge remains unchanged for five to six months, and even longer. Since the vehicle causes the coagulation of the sputum, the clots should be liquefied by treating them with a two per cent. aqueous solution of caustic potassa, before the microscopical examination. The following technical details are recommended by the writer: A small lump is taken out (by means of two sterilized needles, and with the usual bacteriological precautions) from the middle of a clot and placed on a cover-glass, after which two or three drops of the potassa solution are poured over the bit (from a pipette). After two or three seconds, the specimen is covered with another glass slip, the whole compressed with the fingers between the bibulous paper, and the sputum, stained after this or that method in vogue.—*Valerius Idelson, in St. Louis Medical and Surgical Journal.*

A NEW TEST FOR ALBUMEN AND OTHER PROTEIDS.*—Dr. John A. McWilliam gives, in *The British Medical Journal,* a method of testing for proteids by salicyl-sulphonic acid. Take a small amount of urine (for example, 20 minims), preferably in a very small test-tube, and add a drop or two of a *saturated* watery solution of the reagent. If the urine is strongly alkaline, an extra drop or two of the acid should be added, and, if no opalescence or precipitate occurs, it is well to test the reaction with litmus paper, and make sure that the urine has been rendered strongly acid. On adding the reagent, shake the tube quickly, so as to mix its contents. Then examine at once. The occurrence of an opalescence, or cloudiness, *immediately or within a very few seconds* (for example, 2 to 3 seconds), is a test for proteids, intermediate in delicacy between the cold nitric acid test on the one hand, and the acetic acid and heat test (in favorable circumstances) on the other. The development of an opalescence some time after (for example, ½ to 2 minutes), is a more delicate test than even acetic acid and heat, and shows the presence of minute traces of proteid, which are probably insignificant from a clinical point of view, as a rule.

Next, heat the tube to the boiling point. If the precipitate, or opalescence, is caused by the ordinary "albumen" (albumen and globulin), commonly present in albuminous urine, it does not disappear on heating, but, on the other hand, becomes markedly flocculent. But, if the precipitate, or opalescence, is due to the presence of albumoses or peptones, it clears up on heating (before the boiling point is reached), and reappears when the tube cools.

THE PHENYL-HYDRAZIN TEST FOR SUGAR.—Havilburg (*Centralbl. fur klin, Medicin,* January 31, 1891), of Rio de Janeiro, proposes a modification of the Fischer-Jaksch test for the presence of sugar in the urine, which he considers more reliable. Two parts of phenyl-hydrazin hydrochlorate and three of sodium acetate are added to half a test-tube full of water, to which a like quantity of urine to be tested is added. Instead of boiling over a water-bath, the mixture is shaken with chloroform. In a little time the fluids separate. If sugar be present, canary-yellow crystals appear in the upper layer. The reaction is more striking if the fluid is boiled and permitted to cool before the addition of chloroform. Havilburg suggests that the procedure might be adapted for use as a ready means of quantitative determination of the amount of sugar present.—*American Journal Medical Science.*

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* These matters, though not truly bacteriological, concern the microscopist and bacteriologist.

KUEHNE'S METHYLENE-BLUE METHOD OF STAINING BACTERIA.—This method is especially recommended for staining bacteria in sections of animal tissues, although it is equally applicable to cover-glass preparations made from fresh tissues. The usual differences in the method of staining cover-glass preparations and sections are to be observed.

The advantages to be derived from this method are found in its being applicable to all known forms of bacteria. It eliminates the use of special stains for certain micro-organisms where only their presence is to be demonstrated. It possesses superior powers of differentiation between bacteria and the tissue elements. The method as given by Dr. Kuehne is essentially as follows:

The sections which have been cut by the ordinary method (although Dr. Kuehne recommends the freezing microtome for this purpose) are transferred directly from alcohol to a watch-glass containing carbol-methylene-blue. *First.* The sections should remain in this staining fluid for about half an hour; some bacteria, such as the bacillus of leprosy, requiring a longer time, one to two hours. If the sections remain in the staining fluid for a much longer period, the differentiation between the germs and tissue elements becomes more difficult.

After staining for the desired length of time, the exact period of which will have to be determined by test experiments for the different germs and tissues, the sections are rinsed in clear water and then placed in acidulated water, *second,* until they become a pale blue. They are then washed in a weak watery solution of carbonate of lithium, *third,* and again placed in clear water. This part of the procedure is very important, and to insure good results should be performed with much care. The time that the sections should remain in the decolorizing agents varies with their thickness, histological structure, and the intensity of the stain, making it impossible to give any definite rule to be followed. The degree of decolorization can be very nearly determined at any moment by moving the sections about in the fluid by means of a glass rod. If the section is very thin, or if there are other reasons why it should take up very little of the stain, a momentary immersion in the acidulated water is sufficient. In all cases where the staining process is completed the sections should have a pale blue color, for if darker the over-stained corpuscles and cell-nuclei of the tissue would obscure the bacteria. In cases where it is feared that too much color has been removed in the acid a drop of a saturated watery solution of methylene-blue should be added to the lithium-water.

After the sections have remained in the water for some minutes they are dehydrated in absolute alcohol in which, in difficult cases, a little methylene-blue may be dissolved, and then transferred to a watch-glass containing methylene-blue anilin oil; *fourth,* the sections can be dehydrated in the alcohol without injury to the stained bacteria. The sections are now transferred to pure anilin oil, in which they are rinsed and then placed in some essential oil, as turpentine, where they should remain for two minutes. In order that the sections should be perfectly cleared they are transferred from the turpentine to xylol, from which they are mounted in balsam. It is recommended that the sections should pass successively through two xylol baths in order to secure absolute elimination of the anilin oil. The xylol may be used for a considerable number of sections.

Dr. Kuehne employs a glass rod for transferring the sections from one solution to another instead of the ordinary spatula or section-lifter. The end of a small glass rod is immersed in the fluid containing the section, which is allowed to fold itself over the rod, and in this position it is lifted from the fluid. The end of the rod is then gently immersed in the second liquid, where the section unfolds itself from the rod and floats upon the surface. In this way the danger of tearing the section is diminished and the time required for their transfer from solution to solution is much shortened. This is an important consideration where a large number of sections are to be stained.

First. Carbol-methylene-blue.—This is prepared by grinding in a mortar 1.5 grams of methylene-blue with 10 ccm. of absolute alcohol until dissolved; 100 ccm. of 5 per cent. carbolic acid are gradually added and thoroughly mixed with the alcoholic solution. The resulting liquid is preserved in a well-stoppered bottle, until used. When only a small quantity is to be employed it is better to prepare only a half, or a quarter even, of the above quantity, as its staining power is diminished by long standing. It should always be *filtered* before using.

Second. Weak acidulated water.—To 500 ccm. of distilled water add 10 drops of nitric acid.

Third. Lithium-water.—To 10 ccm. of distilled water add from 6 to 8 drops of a saturated watery solution of carbonate of lithium. The saturated solution may be used as a decolorizing agent in sections with over-stained nuclei.

Fourth. Methylene-blue anilin oil.—About one-half gram of methylene-blue is ground in a mortar with 10 ccm. of pure anilin oil. When the oil is saturated with the coloring matter the entire mass is poured unfiltered into a vial, where the undissolved coloring matter will settle, leaving the saturated supernatant oil clear. To a watch-glass of pure anilin oil add a few drops of the saturated methylene-blue-oil until the desired degree of colorization is obtained.

BACTERIOLOGICAL EXAMINATION OF INFLUENZA.—M. Kirchner (*Zeitschrift f. Hygiene,* Bd. 9, Heft. 3) has made an examination of the bacteria in the sputa and blood of patients suffering from influenza, and, from the thoroughness of the work and the uniformity of the results, his observations appear to be very trustworthy. The examinations were made upon thirty patients in the military garrison in Hanover, Germany. Cultures were made in all cases where it was possible, but circumstances prevented the attempt to cultivate organisms in some cases. Still the microscopic examination in all and the cultures in the cases where these were made showed the constant presence of an organism with distinct characteristics.

This organism was the only one found in the blood and the only one which was found in every case in the sputa. It is a diplococcus much smaller than Fraenkel's diplococcus pneumoniæ (Sternberg's micrococcus Pasteuri), and the distance between the two cocci is greater in the former than in the latter. The latter has somewhat pointed ends, whereas Kirchner's diplococcus has perfectly rounded ends. Kirchner's organism grows much more vigorously on agar than Fraenkel's, though like the latter it only grows at a high temperature, but does not die out as rapidly. The experiments upon animals are not yet complete; but where a culture of the organism was injected into the thoracic cavity of a guinea-pig, the animal died in twenty-four hours. and the organisms were found in the lungs. Inoculations under the skin had no effect. The diplococcus, judging from these experiments, seems not to have special pathogenic properties.

[Although Kirchner's observations make it probable that the diplococcus described above is the cause of epidemic influenza, one of Koch's postulates is unfulfilled, viz., the production of influenza or a similar disease by inoculating pure cultures in animals; maybe this test is impossible, for, as in several other cases, it is possible that lower animals are not susceptible to influenza. This makes the proof that the organism is the cause of the disease much more difficult, and necessarily leaves the matter in doubt.]

DISINFECTION.—The question of disinfection would seem to be one which had long ago been exhausted, and yet Behring (Desinfection, Desinfectionsmittel und Desinfectionsmethoden, *ibid.*) has published the results of experiments carried on in the Hygienic Institute in Berlin, which show that in much of the work done under this head many important conditions were lost sight of. It will not be possible in this review to give even a meager outline of Behring's experiments, but the original article is worthy of careful study, as it is a most thorough treatment of the subject.

Behring points out that in all experiments on disinfection the following points must be taken into consideration:

"*First.* The unquestionable proof [in any given case] that the disinfection has been accomplished, *i. e.*, the real killing of the organisms [not merely the prevention of growth].

"*Second.* The chemical character of the material to be disinfected.

"*Third.* The kind of bacteria.

"*Fourth.* The length of time that the disinfectant works.

"*Fifth.* The temperature at which the disinfectant is made to work.

"*Sixth.* The number of bacteria."

Behring shows that the above points have not all been considered, as a rule, in previous experiments with disinfectants, and hence are faulty.—*The Brooklyn Medical Journal.*

DIAGNOSTIC EXAMINATION.—Dr. Laveran gives a very clear account of his methods of examination of the blood in cases of malaria. He points out that such examination is exceedingly necessary in hot countries, where typhoid fever or sunstroke may be mistaken for malaria, or *vice versa.* An examination of the blood always puts the matter beyond doubt. He recommends that the examination should be made just at the beginning of a febrile attack, and before quinine has been administered, as during the period of apyrexia the organisms are seldom found in the peripheral circulation, but appear to be collected in the internal organs, and especially in the spleen. For the examination of the fresh blood, the skin should be cleansed with soap and water, rinsed with alcohol and carefully dried, then, everything being ready, the finger is pricked with a pin that has been heated to redness, and allowed to cool, the little round globule of blood that appears is touched with a clean slide; a cover glass is lowered down onto the blood, which is pressed out until the film assumes a transparent yellow color; the film is then not too thick, and should be examined at once. The clot that is formed at the margin prevents the drying of the film; but, in order to keep the film thin, it is better to wipe away the blood that is pressed from under the cover glass, and then to surround with paraffine. Daylight and no sub-stage condenser should be used for examinations, or the organisms are rendered too transparent. The movements of the flagella and the amœboid movements can all be made out. If the organisms are pigmented they are readily enough seen, but a most careful search may have to be made for those non-pigmented organisms that sometimes adhere to the red blood corpuscles. If the specimen is to be preserved for further examination the film should be prepared by compressing between two cover glasses, which are carefully separated, allowed to dry, and passed two or three times through a clear flame; each film is mounted unstained and dry, with a paraffine rim to keep out the air, and to retain the cover glasses in position. When it is wished to stain the organisms in order to bring them into special prominence, the films, after being heated on the cover glass, are put into a mixture of acohol and ether; they are then allowed to dry, after which they are stained with a concentrated aqueous solution of methylene-blue for thirty seconds; they are then rinsed in water and mounted dry, the cover glass being surrounded with paraffin. The leucocytes are colored deep blue, the free spherical organisms and those adhering to the red blood corpuscles pale blue, whilst other forms are scarcely tinged. A contrast stain may be obtained by using eosin. With these stained preparations artificial light may of course be used. In all cases where possible both methods of preparation should be resorted to, as each has its advantages.—*British Medical Journal.*

BACILLI IN SYPHILIS.—Dr. von Marschalko, who has been working in the pathological laboratory of the Buda-Pesth University, at the subject of the bacteriology of syphilis, has devised a method of staining, by which bacilli may be found in syphilitic growths of various kinds—such as papules on the skin, the indurated base of a chancre, and condylomata, as well as in the secretion of primary sores, while he has not been able to find them in non-syphilitic growths, or in the secretion of soft chancres. Whether they are really inseparably connected with syphilis, can, of course, only be decided by a prolonged series of observations, but there would at least appear to have been a *prima-facie* case made out for further investigation. The method employed is by double staining, as follows: The object, after having been hardened in alcohol, is immersed for thirty-six hours in an alkaline solution of methyl blue; it is then rinsed well with water, and restained by a concentrated solution of vesuvin in water. The bacilli are stained blue, and can be easily distinguished from the tissues, which are brown.—*Medical and Surgical Reporter.*

REMEDIES AND CLINICAL NOTES.

HERPES GENITALIS.

℞	Acid. Carb.	m. xxx.
	Tarro-Petrolene	℥ ij.

M. ft. ungt. Sig.: Apply two or three times, daily.

Note: Pyoktanine may be added in the quantity of, say, gr. v. or substituted for carbolic acid in the dose of ten grains.

SUMMER DISTURBANCES OF CHILDREN.

In fermentative disorders of the alimentary canal in the young, middle-aged or old, Listerine has given most satisfactory results. In the summer diarrhœa of children, Dr. I. N. Love, of St. Louis, speaks very highly of it, given in combination with glycerine and simple syrup. A formula that I have time and again used—in fact, it has almost become routine with me of late years—is as follows:

℞	Bismuth Sub. Nit.	half a drachm.
	Tr. Opii	twenty drops.
	Syr. Ipecac	
	Syr. Rhei Arom.	aa two drachms.
	Listerine	half an ounce.
	Mist. Creta	one ounce.

M. Sig.—Teaspoonful as often as necessary, but not more frequently than every three or four hours. This for children about ten or twelve months old.

D. J. Roberts, M. D., in *Southern Practitioner.*

QUERIES AND ANSWERS.

Mr. Editor.—Which speedy permanent treatment for rebellious, syphilitic ulceration on nose and upper lip do you advise?

A SUBSCRIBER.

A. This is not a question properly belonging to bacteriology and the editor is not a specialist in skin diseases. However, a competent physician to whom this question was submitted says: Use Iodide of Potassium internally at the highest possible dose and apply the following locally and constantly:

℞	Hydrargyri Chlorid. Corrosiv	gr. ij.
	Aristol	ʒ j.
	Tarro-Petrolene	℥ ij.

M. ft. oint. Sig.: Apply two or three times daily after one good scraping of surface of ulcers and drying.

J. B. W., M. D.

LABORATORY NOTES.

SECOND REPORT.

DEAR SIR:—Since the opening of the Chicago Pasteur Institute (July 2, 1890) 55 persons have received treatment.

Thirty-one came from Illinois—10 from Iowa—4 from Indiana—2 from Ohio—2 from Minnesota—1 from Missouri—1 from Tennessee—2 from Kentucky—1 from South Dakota—1 from Arizona.

Thirty-six were male and nineteen female.

The youngest patient was 2½ years old and the oldest 56. Fifty-one were bitten by dogs, three by cats and one by a skunk.

Thirty-one persons were bitten in the hands and arms, three in the face, and twenty in the body and legs. Twenty-four had their wounds cauterized with chemical agents, and thirty-one had not.

Thirty-three persons were bitten by animals recognized and ascertained of being rabid, by experiments made upon rabbits, by the death of persons and other animals bitten by the same, or by symptoms shown during life; and twenty-two persons were bitten by animals strongly suspected of being rabid.

All the persons treated are now enjoying good health.

Adhering to the principles of strict and careful sterilization of all instruments and fluids used, no abscesses nor inflammations nor even irritation of any kind occurred at the seat of inoculations, thus testing the *purity* of the material used.

It has been made a practice at this institute never to submit persons to treatment, *unless in need of it;* consequently ninety-six persons were refused treatment as not reasonable evidence was produced to demonstrate the madness of the animals; all these persons are also in good health confirming the correctness of our judgment.

A. Lagorio, M. D.
Chicago, May 1, 1891. Director.

READING NOTICE.

The Bacteriological World takes pleasure in drawing attention to the following very important announcement:

We are gratified to inform our readers that arrangements have just been completed, and contracts signed, by which we have been appointed sole agents for the United States and Canada for the sale of the famous microscopes and objectives of Charles Reichert, of Vienna. His objectives stand in the very front rank. His microscopes are eminently esteemed in the laboratories of Europe. Further announcements in regard to catalogues, etc., will be made in due course.

Respectfully,
James W. Queen & Co.

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A Monthly Illustrated Magazine Devoted to the Study of Micro-Organisms and Specific Maladies.

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EDITORIAL.

SPECIFICITY OR NON-SPECIFICITY OF PULMONARY CONSUMPTION.

In a paper read the third of June before the Pennsylvania State Medical Society, Dr. Thos. J. Mays, takes the ground that pulmonary consumption is not a specific disease and not produced by contagion. The following words of his explain the views he holds ;

"It goes without saying that the successful treatment of pulmonary consumption depends entirely on a correct and rational view of its origin. On this ground, there can be no division of opinion. Unfortunately, however, one part of the profession holds that the tubercle bacillus is the sole cause of the disease ; while the other part believes that the disease depends on numerous other causes, and that the bacillus is merely one of its products or concomitants.

"Now, it must be confessed that diametrically opposite opinions on a question of such tremendous practical and public importance are no great credit to a profession which is justly proud of her logical conquests, and which rightfully rejoices in her scientific achievements, and in her work of philanthropy. Especially is this a misfortune when we consider that the whole difficulty rests on an erroneous interpretation of the fundamental terms which are involved in the question; and, in endeavoring to prove this, I desire it to be perfectly understood at the outset, that I yield to no one in my admiration of, and I might even say in my veneration for, those pains-taking explorers who so patiently and assiduously devote their life and energies to the investigation of this fearful malady. But I do not regard this as a question of personal reverence. It is one which must determine the true relation of the consumptive to his family, to his friends, and to society; whether or not he is to be looked upon as a center of infection, a source of danger, and liable to spread the disease among those who are well.

"Where then lies the fundamental misapprehension? It is, *first,* in affirming that, because a disease is capable of being communicated from one animal to another through inoculation, that, therefore, it must be contagious or infectious among the human species; *second,* in holding that the disease (tuberculosis) which is produced artificially in animals through inoculation is the same as that (consumption) which is naturally produced in man."

We believe Prof. Mays perfectly sincere in his opinion and doubt not in the least the noble animus of his excellent contribution.

However, we fail to see in the same light and believe that no statistic, bedside or hospital record warrants the assertion nor even the assumption that tuberculosis is not a specific affection. In fact, the very statistics and reports which the learned Doctor quotes copiously are insufficient, in our humble judgment, to support his conclusions, and many may be satisfactorily and rationally explained under the principle of contagiousness.

In the first place it is true that a part of the profession holds that the bacillus of Koch is the sole cause of the disease in question whilst the other part holds that the bacillus is "one of the products or concomitants of the affection." But if we judge from writings, medical journals, discussions, congresses, association meetings in the whole universe, the reports of foreign academies and learned societies, the oft-repeated opinions of the most learned and most practical physicians of all countries, the part of the medical profession which holds that the bacillus is "one of the products of consumption" sinks into insignificance compared with the other part, the mass of practitioners who believe the reverse.

The Doctor gives in the above lines what he holds as the fundamental misapprehension that leads so many to believe in the contagiousness of tuberculosis. First, he considers it an error to conclude that "because a disease is capable of being communicated from one animal to another through inoculation, that, therefore, it must be contagious or infectious among the human species."

This is undoubtedly a positive evidence that (lower) animal tuberculosis is *transmissible*, and a transmissible disease is a *specific* one. And that tuberculosis of man and beast is identical seems positively proven by numerous observations of some of the most accurate practitioners as well as laboratory investigators, by the transmission of the disease from man to animals, not only by *inoculation* but also by *inhalation* of human tuberculous sputa, thereby causing pulmonary tuberculosis to develop in animals, and also by the *ingestion* of human tuberculous sputa producing tuberculosis in the intestines, etc., of the animal subjects so treated.

The disease thus produced is similar in its action upon the organs affected as it is in man when it occurs accidentally. The same organisms, the same pathological lesions and the tuberculosis products have the same virulence.

These facts, which answer the second so-called misapprehension as well as the first of Dr. Mays, are not derived only from inoculations among lower animals as you see but by transmission of the disease from man to animals by *various means*—inoculation being only one of the various methods of conveying it.

But still more has been done to prove the specificity of tuberculosis in man. The *Gazette Medical de Paris*, 1872, No.

17, gives an account of one inoculation made with sputa on a man of 55 years by three bold Greek physicians, Demet, Paraskeva and Zallonis, of Syria.

They had a patient affected with gangrene of the big toe of the left foot, and in whom nothing whatever indicated the slightest predisposition to tuberculosis. His lungs were sound so far as the ear and various methods of diagnosis could find. Three weeks after, the experimentalists detected at the summit of the right lung the beginning of an induration. The thirty-eighth day the patient died from the effects of the gangrene. *Post-mortem* examination revealed seventeen tubercles at the summit of the right lung where they had diagnosed induration ; two were found on the upper portion of the left lung and two more on the liver. The doctors thought the tubercles advanced in proportion to the lapse of time between inoculation and death.

Certainly this fact in itself is not conclusive, but it is a very strong addition to the many other evidences of the positive contagiousness of tuberculosis.

In denying that by inoculation or transmission we do establish the proof of the specific nature of tuberculosis, one must also deny that inoculation or any other processes of transmission of any other malady is in any sense evidence of specificity.

If this is true, then, the inoculation of glanders between animals or from animal to man ; the inoculation of anthrax between animals or from animal to man ; the inoculation of vaccinia from bovines to man or among the human species ; the inoculation of septicemia between animals or from animal to man are in no sense evidence of specificity.

In fact the basis from which Dr. Mays reached his conclusion that the mass of medical men who believe in the contagiousness of consumption have misinterpreted the bearing of inoculation, etc., etc., furnishes equal grounds for the denial of the specificity of every known and contagious disease in the world.

It is only by transmission of a disease that one can positively and undeniably establish its specific nature.

LESSONS IN BACTERIOLOGY.

LESSON FIFTH (*continued*).

BY PAUL PAQUIN, M. D.

CULTIVATION OF BACTERIA.*

Before proceeding with the second part of this lesson, I wish to make clearer, correct the sense, and add to two or three statements made in the last lesson.

First, regarding the sterilization of blood serum, which we will see in detail, I wish to say that it may be effected also in a water bath though not so safely as in dry air. (See twelfth line from the bottom, page 314, May number of this magazine.)

Second, a beef broth culture containing gelatine will be better and more solid when heated from five to six or ten minutes two to four consecutive days at a moist temperature of not over 212° F. (See page 314, first and second lines from the bottom, and the first line at the top of page 315.)

PART II.

ESSENTIAL APPARATUS TO CULTIVATE BACTERIA.

The first requisite is apparatus of culture presenting simplicity, solidity, convenience and cheapness as far as possible. The second is the proper preparation of culture media.

APPARATUS.—The most commonly used recipients are test tubes, the most suitable kind being the narrow, thick tubes without flange at the mouth. Little culture flasks, as the Pasteur flask for instance, are also in use. However, in a case of necessity, one might utilize ordinary little round medicine bottles.

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* Illustrations from Salmonsen's Technology, French edition.

The tubes, bottles or flasks are first to be washed carefully and thoroughly in distilled or at least boiled water and allowed to drain well. A good-sized bundle of cotton wool is twisted with the fingers and adjusted exactly, an inch or two in depth, in the opening of each, leaving a projection over the edges. (See Fig. 7.) This plug must be dense and tight enough to prevent the introduction of air germs, but yet not so tight-fitting as to be difficult of moving by a gentle, firm tortion motion. When plugged they are placed in a wire basket, say, or a perforated metallic bucket of small size and the whole introduced into a dry heat sterilizer. (See Fig. 6, A.)

Leave them there at about 280° F. for ten or twenty minutes or until the cotton wool plugs begin to be slightly brownish. Thus sterilized, and as soon as cooled, the tubes or bottles are ready to serve as recipients of culture media. These apparatus are for liquids or semi-liquids.

There are other culture apparatus in use for such culture media, but I intend to give you only the simplest and most economical that may be used advantageously without any expensive laboratory arrangement and without the knowledge of difficult special details of laboratory technique. For cultivation of bacteria on more solid matter, as on potato for instance, glass dishes are used as recipients. They are composed of two flat glass dishes, the larger serving as cover for the smaller. (Cut will appear in next issue.)

To prepare them they should be well washed as the test tubes, drained, and a circular sheet of absorbent paper dampened with a bi-chloride of mercury solution placed in the bottom of the smaller dish. The solid culture media are carefully placed inside and covered.

Practice alone will teach the skill necessary for these manipulations without the introduction of air germs; further we will note these manipulations more in detail.

All these apparatus are for the cultivation of *aerobic* bacteria. The *anaerobic* need special treatment, and we will consider them apart.

There are special apparatus, some sort of incubators, to keep the cultures at any temperature desired. Of these we shall speak in due time.

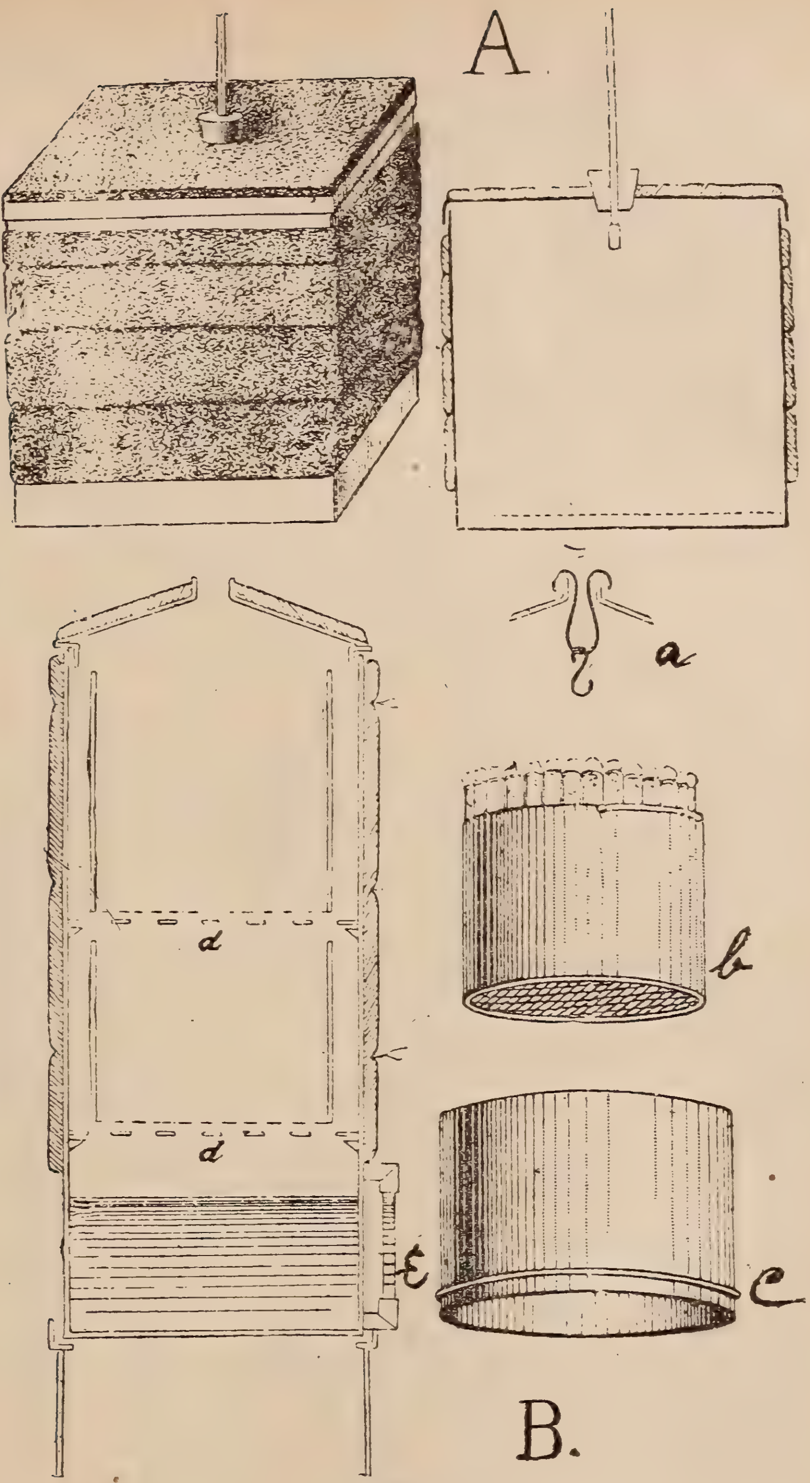

FIG. 6.

A. Dry Heat Sterilizing Oven; a common metallic box covered with pelt.

B. Koch's Steam Sterilizer: *a*, hook to suspend objects; *b*, metallic bucket containing plugged test-tubes; *c*, metallic cylinder to augment height of apparatus; *d*, *d*, perforated metallic plate; *e*, water guage.

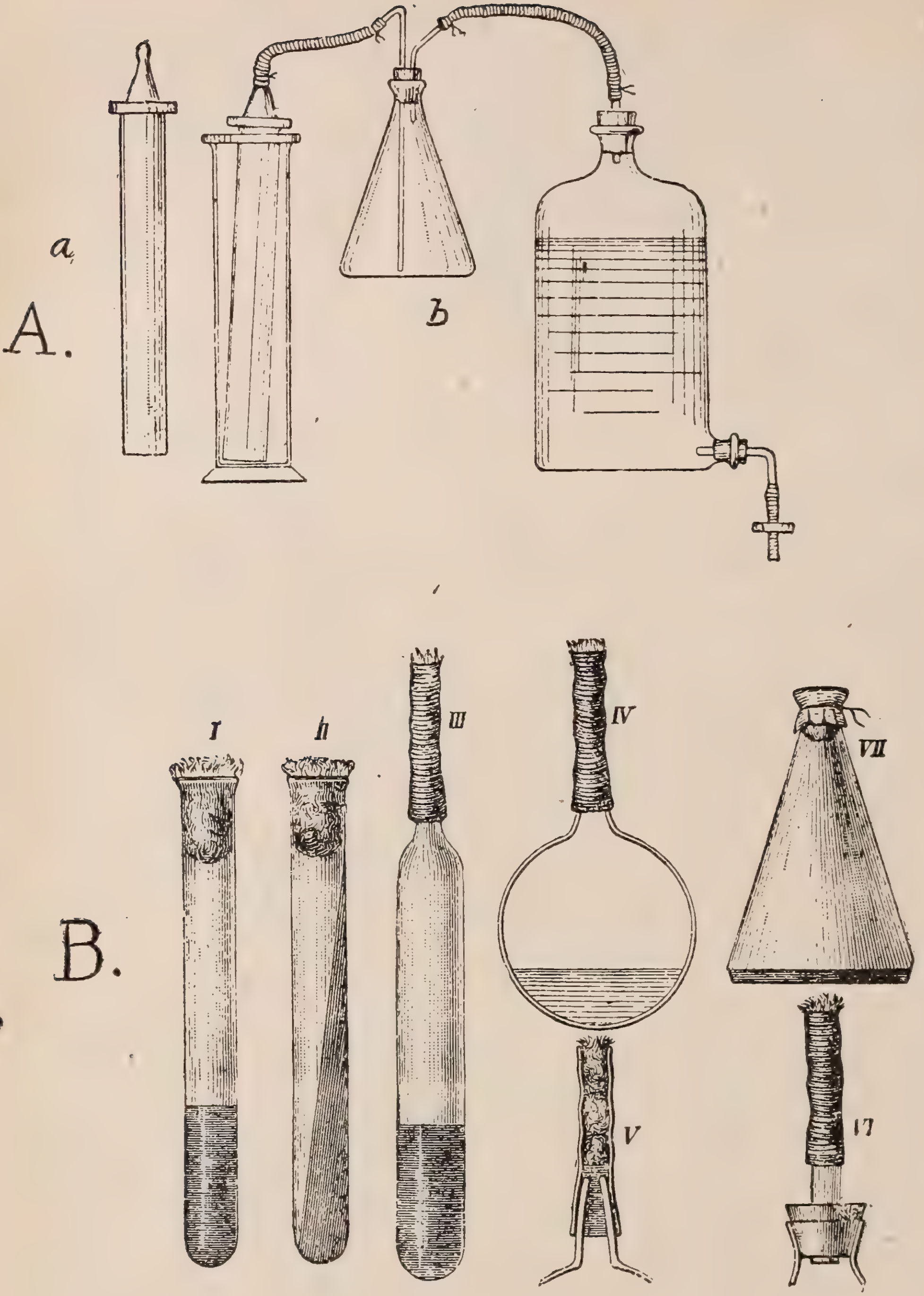

FIG. 7.

A.-*a*. Chamberland Porcelain Filter *bougie;* *b*, the Filter in operation by means of Aspirator.

B. Various Culture Vessels—Test-Tubes and Flasks: I, II, VII plugged with cotton—wool; V, VI, provided with tubular corks or plugs.

LESSON SIXTH.

CULTURE MEDIA AND PROCESSES OF PREPARATION.

Among the many nutritious preparations to cultivate bacteria, I will here give you only those which have proven successful with the majority of organisms. The laboratory worker has his media of predilection and changes them to suit his special needs in his particular operations.

Broths in general.—The juice obtained in boiling lean meat, such as beef, pork, chicken, etc., even with its acid reaction is suitable to grow various micro-organisms. But if neutralized by the addition of bi-carbonate of soda, it is still better and affords proper nourishment for a number of pathogenic germs.

It should be noted, at the onset, that variety in the quantity and quality of nutritive principles in a given media may result in differences in the growths in general, and even in a measure produce different microscopic appearances in the same individual.

Beef broth.—Take one pound of very lean beef chopped fine; one litre of water, put into an enameled kettle, or a large glass flask which may be placed in a water bath, boil thirty minutes and filter. The filtrate should then be neutralized by adding drop by drop while stirring a saturated solution of bi-carbonate or phosphate of soda. Test the liquid often with litmus paper while doing this, in order to stop the addition of alkaline liquid the moment it becomes neutral or slightly alkaline. Add one-half dram of common salt. After this boil the filtrate again to coagulate all the insoluble albumenoids. The addition of the white of an egg before beginning this second cooking is of material assistance in clarifying the broth. Let the liquid stand until cool, filter again, and put into the sterilized test tubes, bottles or culture flasks spoken of, or put into a large sterilized glass flask to keep as stock culture broth to be drawn from at convenience in the future. The test tubes or other bottles (in which the cultures are to be made) should be about one quarter full Replace the cotton plugs immediately after liquid is in them.

These culture recipients and their broth are then placed in a steam sterilizer and heated to over 300°F. five or ten minutes, and complete sterilization is effected. In case one has no steam sterilizer, the media should be placed in a wire basket or perforated tin pail say, and boiled for about thirty minutes once a day for three to six days in a water bath.

Cloudiness may spoil the appearance and even utility of broths thus prepared. This may be avoided by repeating the cooking process once or twice and the addition of more egg albumen after neutralization as before stated, before putting into the test tubes or other culture vessels.

Five per cent. of pure glycerine added to this before neutralization renders it proper to grow the bacillus of tuberculosis. The addition of one to two per cent. of peptone, a little cane sugar, etc., is also occasionally resorted to particularly for the cultivation of *anaerobic* organisms.

LIVER BROTH.—We use in our laboratory, liver broth (subject to solidification by gelatine, etc.) which at first I had prepared somewhat on the principle of beef broth but which was afterwards beneficially modified by my assistant, Dr. Paul Evans. The modified method is as follows:

Take one pound of finely chopped beef liver and put in a two litre flask with one litre of distilled water. Heat in water bath for half an hour at about or below 212° F. and press the liquid through a fine gauze or clean linen cloth. Boil the liquid for an hour or more and filter. Put in four per cent. glycerine, carefully neutralize with sodium carbonate (make slightly alkaline rather than acid). Add white of an egg and boil again a few minutes. Filter again. Sterilize carefully one hour once a day for three to four days at boiling point in steam sterilizer or water bath.

Another fluid which I have used in the laboratory is the following:

Phosphate of magnesium	20	grains
Chloride of sodium	20	"
Carb. of sodium	15	"
Nitrate of ammonium	10	"
Carbonate of potassium	10	"
Sulphuric acid	30	drops
Water	6	ounces
Beef broth (prepared as stated)	1	litre

Dissolve the salts in a part of the water, say half, and the acid in the remainder, then add each solution to the broth while stirring. Neutralize, put in culture tubes or flasks and sterilize at 212° F. repeatedly, or at once at over 300° F.

This is a special medium used in special investigations as we may see further, but not proper for the growth of all organisms.

VEGETABLE INFUSIONS.—Besides these animal substances, various vegetable infusions are used as nutritive media. Thus hay, wheat, cabbage, potato infusions made by boiling these and sterilization as for other substances are occasionally employed. I need not dwell on these. They are very simple.

Again DECOCTIONS OF FRUITS are in use for the growth of organisms such as fungi, moulds, etc. Among these may be mentioned the plum decoction that Salmonsen speaks of. I have cultivated organisms of various kinds on fresh ripe grape decoctions.

In the study of pathogenic bacteria acting on animal tissues these are of little value except the potato decoction which has some utility.

SOME SOLID CULTURES.—The animal broths described may be solidified very profitably for the cultivation of bacteria on a smooth surface or in the center of their transparent substance, thus affording the opportunity of following the growths step by step with the naked eye, watching their progress, appearance and action on the nutrient matter.

To solidify the meat broths, *gelatine* or *agar-agar* (from gelatinous algues) or both are added as follows: Add from 5 to 10 per cent. of the best quality of gelatine in clear thin plates or fibers to the broth before neutralization. Dissolve at a low heat, neutralize or make slightly alkaline, then heat to about boiling point; filter whilst hot for in cooling or after cooling, it will not filter. There are water baths, filters or hot water filters on the market for this purpose. They have the advantage of keeping the liquid at a constant heat whilst being filtered directly into a sterilized stock flask or into the culture tubes.

In using agar-agar, the broth should be made slightly alkaline before its addition because if cooked in an acid solution it will form sugar. The remainder of the process of preparation is as for gelatine. The quantity used is 1·5 to 1·2 per cent.

Jensen had the happy idea to combine agar-agar and gelatine and thus improve the jelly medium. This combination is effected in the proportion of 5 per cent. of gelatine and 0.75 per cent. of agar, taking care to add the agar, as just stated after a slight alkalinization, or at least neutralization of the fluid, and not before as is done with gelatine.

(Sixth lesson continued in July number.)

ORIGINAL ARTICLES.

SORE THROAT AND PURULENT PLEURISY WITH STREPTOCOCCI.

BY M. HANOT,
Before the Hospital Medical Society, Paris.

We admit to-day that a certain number of sore throats are microbic in origin, but the precise documents on the matter do not permit us to establish yet a new satisfactory classification. This is why I have thought it my duty to present to the society the observation of a sore throat by streptococci, the evolution of which has shown that such a sore throat may present signs to the deepest infection and be followed with the gravest complications.

Here is, in short, this observation:

X——, aged 19 years, resident of Paris for 5 months, came under my care the seventh of March, 1889; nothing in the antecedents.

Twelve days previous there was a violent sore throat, with lassitude, anorexy, fever, prostration. In the night of the third to fourth, violent stitch in the side.

At his entrance into the hospital the prostration was great. The patient responded painfully to the questions we addressed to him. Feverish tongue. Uniform red tint of the pharyngeal mucous surfaces. The tonsils did not seem augmented in volume, but they were painful. No false membranes; not of adenopathy, nor epistaxis, nor vomiting; liver extending the false ribs a finger's breadth; urine slightly urobilic, with a cloud of albumen; acute dyspepsia; signs of pleuritic effusion in the right, in the inferior, two-thirds; pulse, 90; temperature in the neighborhood of 100½° F.

The general state is worse than could be expected in the ordinary pleurisy. Therefore we diagnosed an infectious pleurisy of pharyngeal origin.

Treatment: milk, broth, tonics, 15 grains of sulphate of quinine.

The eleventh of March the prostration is the same, diarrhœa augmented. An exploring puncture gives issue to a little clouded, flaky liquid, in which we find numerous streptococci. An evacuating opening brings forth afterwards nearly a pint of liquid.

The twenty-first, the general state and local condition being the same, a new puncture permits the evacuation of one pound of purulent liquid. Temperature over 102° F.; pulse, 128; respiration, 50.

The twenty-fifth, empyema in place of election; issue of a litre of pus; antiseptic wash of the pleural cavity (solution of chloride of zinc 2 per cent., and boric solution 4 per cent); drainage.

The temperature, which in the morning was nearly 103° F., instead of falling, as in the fortunate cases, rose to above 104°F. The general state also remains serious. The patient is as if mummified in his bed, and presents the maximum signs of infection. The muscles are literally melted; dull color; complete anorexia. Finally, death, the twenty-fourth of April.

At the autopsy we ascertained that the amygdales, hardly more voluminous than normal, contained small abscesses of the size of the head of a pin to that of a pea. The tissue, retropharyngeal, cellular tissue, is the seat of a well-confined lateral purulent streak, a centimetre and a half in width, directing itself towards the right, from the summit of the thoracic cage. There, loosening the parietal pleura of the thoracic wall, it descended to the level of the inferior third of the chest, where it opened in the interior of the serous cavity. The right pleural cavity did not contain liquid ; its walls were covered with thin grayish false membranes. The right lung is congested and not hepatized in the superior two-thirds, atelectasis in its inferior third. No tubercles. The left lung was wholly congested.

The purulent channel contained some streptococci. The same micro-organisms have been found in the amygdalien abscesses.

Nothing particular to note in the other organs.

I will draw your attention in connection with this case, that Messrs. Cornil and Babes, in their book, mentioned the presence of streptococci in abscesses of the amygdales.

There was described, said Mr. Fernet, in discussing the above report, a certain number of serous pleurisies ; these are tuberculous, rheumatic, scarlatinous, pleuritic, consecutive to other diseases, or to the affection of the neighboring organs.

Mr. Netter has said to us that, bacteriologically, 70 per cent. of serous pleurisies were tuberculous. And in the 30 per cent. which remained Mr. Talamon has found twice the pneumococcus, three times the streptococcus, in 17 cases of pleurisy that he has examined ; we are able then to admit that certain cases of serous pleurisy are produced by the pneumococcus and by the streptococcus. I have just observed one in which Mr. Girode has found the Eberth bacillus. We have noticed sometimes pleurisy coming unexpectedly as complications of typhoid fever.

Messrs. Rendu and Valentini have reported each an observation of purulent pleurisy ; recently, Mr. Charrin reported an observation of hemorrhagic pleurisy. No one has yet reported a case of serofibrinous pleurisy in which has been found the Eberth bacillus.

The case was that of a young man aged 18, who presented all the symptoms of typhoid fever ; the rosy lenticular spots were lacking, it is true, but at the fifteenth day of the affection this fact was nothing astonishing, and this was on the fifteenth day. In searching well in the antecedents, however, we found that the affection had begun six weeks before ; the disease had at this epoch a stitch in the side and symptoms which permit the supposition that the effusion dated back to that time. And it is at the moment that convalescence seemed to establish itself that symptoms analogous to those of the typhoid fever supérvene. A complete examination at the time of his entrance to the hospital led to the discovery of a serous pleurisy in which Mr. Girode found the Eberth bacillus.

I have observed several analogous cases from a symptomological point of view, though bacteriological examinations were either omitted or remained negative, and I ask myself if there is not reason to admit a variety of serofibrinous pleurisy of a typhoidic character.

Mr. Chantemesse remarked, in the discussion, that there are perhaps in certain cases some infections by typhic bacilli. It is thus, he said, that I have seen a case of typhoid fever last five months; that, in another patient, I have seen abscesses due to typhic bacilli occur unexpectedly fifteen months after the typhoid fever; that, finally, in a third, I have seen an osteoarthritis which had lasted three years and which had originated six weeks after a typhoid fever. These facts show how long may last the virulence of the typhic bacillus. Mr. Dupre has found in the pus of a biliary vesicle the Eberth bacillus still virulent a very long time after a typhoid fever.—*Report from La Tribune Medicale.*

MEDICAL BACTERIOLOGY.

THE ELIMINATIVE TREATMENT OF PUERPURAL SEPTICÆMIA.

From a study of infectious diseases in general, and from observations on the methods of elimination of toxic substances from the organism by the natural emunctories, Heliodor de Swiecicki (*Gazette Hebdomadaire de Medecine et de Chirurgie*) advises the employment of these means to rid the system of poison in puerperal septicæmia. Of course, the early treatment of this disease, if the case is seen in time, is, first, by asepis and and antisepsis by means of uterine irrigation, etc.; and, secondly, by the use of alcohol and every means to prevent the poison from overpowering the organism. But, if the morbid germs and their products have surcharged the blood, the author says, the production of exaggerated diuresis and diaphoresis would be a rational method of eliminating the morbid elements. The treatment consists of subcutaneous injections of pilocarpine and the drinking of large and frequent draughts of sterilized chloride of sodium solution. If there is any difficulty in the patient's swallowing the solution, it is to be introduced directly into the stomach by means of a tube. The author reports the success of this method of treatment in several grave cases of puerperal septicæmia. The amelioration of the symptoms was prompt, the temperature falling, the pulse becoming less rapid, and the rigors disappearing in a very short time. The patient must be watched closely for any sign of heart failure; in the event of which small doses of alcohol are to be given.—*Exchange.*

NEW TREATMENT OF PHTHISIS.

BY GERMAIN SEE.

The author shuts his patient up for two, three or more hours daily in a hermetically closed metallic chamber, into which is slowly admitted a current of compressed air, which, having passed through a mixture of creosote and eucalyptol, is saturated with the vapor of these substances. Since August last ten cases of phthisis have been submitted to this treatment, all of which cases, with one exception, had reached the period of softening, and bacilli had been detected in the sputa. The results obtained were: Return of appetite, even in advanced cases, gain of weight and strength, fall of temperature to the normal in a week or two, disappearance of hæmoptysis, diminution of cough and of purulency of sputa, cessation of dyspnœa. It is claimed that the method reduces the malady to a purely local lesion, all the general symptoms disappearing, even though rales may persist. M. See related the history of seven of his cases, all of which were relieved, and some actually cured. The treatment has been found efficacious in fetid bronchitis (dilatation of the bronchi).

SURGICAL BACTERIOLOGY.

THE ACTION OF TRYPSIN, PANCREATIC EXTRACT AND PEPSIN UPON SLOUGHS, COAGULA AND MUCO-PUS.

BY R. T. MORRIS.

Something more than peroxide of hydrogen is wanted for managing the abscess cavities of tuberculous bone disease to our entire satisfaction. It is true that with hydrogen peroxide at hand we can open the biggest of cold abscesses in a feeling of security for the patient, and yet it is desirable to get the tough lining membrane of fibrinous lymph and the loose coagula and the sloughing diseased tissues out of the way as thoroughly as possible; for once these substances have begun to seethe in fermentative processes, we are hard pressed to keep the patient out of trouble.

The sharp spoon and scissors will do the work, to be sure, but only after tedious labor and egregious wounding of the weak patient.

A resource was brought into play a few weeks ago when I had occasion to make suggestions relative to the treatment of a crushed liver. Portions of the organ, which were dark and sloughing, remained so firmly attached that their removal was dangerous, and the pultaceous lining membrane of the enormous abscess seemed to invite all manner of microbe guests. The idea of liquefying the dead tissues with a digestive ferment came into mind, and this being suggested was carried into effect by the family physician, who injected into the abscess cavity a solution of scale pepsin, and writing to me afterward, said: "The pepsin did mighty good work. It broke up all dead tissues, rendering them mostly liquid, and changed the color from brown to straw color. The liquefied substances were easily washed out through the drainage-tube. The wound was sterilized daily afterward with hydrogen peroxide, and the patient recovered without a bad symptom."

On theoretical grounds I had supposed that trypsin would be the best liquefier, that pancreatic extract would stand next in value, and that pepsin would be used only when it was inconvenient to obtain the other ferments; but when it came to a practical test, pepsin led all the rest. Experiments, which were carefully made for me in detail by Dr. Charles N. Haskell, I will refer to only in a brief way here. Dr. Haskell used tough, partially dried blood coagula for test purposes, and the trypsin, pancreatic extract and pepsin were fresh. As a result of numerous experiments, it was determined that four grams of pepsin dissolved in three hundred cubic centimetres water, acidulated with one per cent. of hydrochloric acid and applied to one hundred grams of the coagula at a temperature somewhat above 100° F., would liquefy the coagula in thirty-six minutes.

Pancreatic extract used in alkaline solution, other factors being as in the pepsin experiment, required two hours and twenty-six minutes for liquefying the coagula, and at the end of that time little tough knots of fibrin still remained.

Trypsin in alkaline solution, and used in the same proportions and under the same conditions as the pancreatic extract and the pepsin, required two hours and ten minutes for liquefying the one hundred grams of coagula.

From these experiments it seems that a 10-per-cent. solution of the best pepsin acidulated with 1 per cent. of hydrochloric acid, and heated to a temperature above 100° F. (not over 120° F.), will be proper for surgical purposes.

We need not employ the pepsin until the patient has recovered from the effects of ether after an operation, and then the liquefying process can be attended to at leisure. The abscess cavity should be washed out with boiled water, for antiseptic solutions would interfere with the action of a digestive ferment. The patient then assuming a good position for holding the pepsin solution in the abscess cavity, he can receive the hot injection; and hot fomentations continued for an hour will promote the action of the ferment down below.

Bad tissues sufficiently liquefied are washed out with boiled water, and the whole wound is then sterilized with peroxide of hydrogen and prepared according to the surgical conception of neatness.

The facts relative to the comparative activity of the digestive ferments were not known to me at the time when I asked friends to collect practical points for this paper.

Dr. C. N. Haskell liquefied two grams of tough lining membrane from the tuberculous abscess of a case of hip-joint disease with pepsin in fifty-five minutes.

Dr. C. D. Jones, of Brooklyn, poured a solution of pancreatic extract (pancreatic extract, ʒij; water, ℥viij) into the abscess cavity of a case of hip-joint disease one week after the operation of excision had been perfected. He then wrote me as follows: "The solution was allowed to remain in place half an hour, and the result was remarkable. Upon irrigation, I washed out numerous shreds of broken-down ligamentous tissue and many spicula of dead bone that had become imbedded in the soft tissues and that had previously escaped both irrigator and curette. The wound was then flushed out with hydrogen peroxide, and this treatment was followed by a marked improvement in the patient's general condition."

Dr. L. A. Zerega applied a thick solution of pancreatic extract to the large slough of a burned wound of the chest, but four hours were required for breaking up and separation of the slough. A thick solution of the pancreatic extract applied to the large sloughs of a case of fracture of the spine failed to liquefy the sloughs after prolonged application. These two experiments were made at my suggestion, and were wrong in theory, as later facts have shown. If a thin solution of pepsin could be applied to such sloughs in a proper way, they would succumb pretty rapidly ; but it is only in case of sloughs situated deep in cavities that we can apply the pepsin in a practical way.

In one case in which the bladder contained blood-clots and the catarrhal mucous membrane discharged ropy muco-pus, pepsin injected for the purpose of liquefying the clots not only fulfilled its mission in that direction, but unexpectedly cleared out the muco-pus and left the interior of the bladder quite clean. The process was repeated as soon as the muco-pus again became abundant, and the patient experienced a feeling of relief after the simple cleansing that pepsin afforded.

I much regret that pepsin was not used in one of my cases of empyema following a bullet wound of the chest. The chest cavity was walled off into compartments by fibrinous bands, and these compartments contained large lymph coagula which were removed with great difficulty. Pepsin would have made simple work of breaking down the bands and liquefying the lymph coagula.

It is not easy to see at a glance the whole field for digestive ferments in surgery, but we know that they are bland and harmless in any proportion, and that they will liquefy dead tissues close down to living ones, and that their action will then end abruptly. The harmless employment of digestive ferments should be the means of saving many a life that otherwise would flicker and go out under the waves of septic infection from decomposing organic matter in the depths of tuberculous abscesses.—*New York Medical Journal.*

SELECTIONS.

STUDIES ON THE ACTION OF DEAD BACTERIA IN THE LIVING BODY.

BY T. MITCHELL PRUDDEN, M. D.

Director of the Laboratory of the Alumni Association, College of Physicians and Surgeons, New York.

FIRST ARTICLE.—INTRODUCTORY.

The researches of the past decade, bringing to light, one after another, the specific micro-organisms of some of the most common and fatal diseases, have been so surprising, so definite, so full of the promise of fruitful outlooks upon hitherto untrodden fields, that we have scarcely yet had time to recover from the glamour of the new light or to realize. in the urgency of fresh practical problems, the exact extent and bearings of the new knowledge.

For a time it seemed enough, and even more than enough, that month by month the proof grew stronger that anthrax, tuberculosis, typhoid fever, erysipelas, pneumonia, tetanus, diphtheria, and a whole group of allied "wound diseases" and others of the so-called "infectious" class, were always associated with certain germs, each peculiar in its life history, and each standing, as we say, in an etiological relationship to its particular disease.

But as we have little by little become accustomed to the new light, it has become evident not only that we are still ignorant about the relationship of micro-organisms to several extremely frequent and important infectious diseases — the exanthemata, for example—but also that when we have learned that a given acute infectious disease is always associated with a particular form of germ, when the life history of that germ is made out, and we can say that it stands in an etiological relationship to the disease, there yet remains a series of accessory problems to be solved in each particular case scarcely less important than the establishment of the invariable association of the germ with the disease.

We are just beginning fairly to realize that the disease is not an entity, a thing imparted by the invading germ to the body, but that it is the result of the reaction of the body cells in the presence of the germs; that the body-cell factor is just as important and just as much in need of study as is the germ-cell factor. We have been largely forgetful, hitherto, as with painful detail the characters and preferences and metabolisms and vulnerabilities of the pathogenic germs have one by one been brought to light, that, before our knowledge of the acute infectious diseases can be at all complete, the characters and preferences and metabolisms and vulnerabilities of the body cells must be subjected to an equally careful scrutiny. The *germ* side of the problem is new and fascinating; the *man* side is old, and cellular pathology is a phrase familiar to our ears. But these old problems have become fairly new in their new light, and cannot too soon be taken up afresh if our knowledge of the acute infectious diseases is to be symmetrical and of lasting use.

Partly by clinical observation and partly by laboratory studies is the new knowledge of the man side of this theme to be acquired, and old clinical observations, which have lain uninterpreted or misinterpreted, and new facts which the new points of view cannot fail to elicit, will surely be fast forthcoming.

But, returning to the bacterial side of the problem, it became evident, very soon after the definite status of pathogenic germs was made out, that something more than their mere presence was necessary to account for the manifestations of the acute infectious diseases.

The early discovery that certain pathogenic germs set free poisonous substances of one kind or another as the result of their life processes, and the evidence that these substances were directly accountable for many of the manifestations of the acute infectious diseases, drew attention to the complexity of the problems involved, called in the services of the physiological chemists, and for a time it seemed, and still does to many, that, after all, it was the poisons which the bacteria elaborated and sent out into the body on their destructive missions which was the most important thing. "Ptomaines" became a favorite word. When we had said that a given germ produced a given disease or effect by the elaboration of a given ptomaine, it seemed to many fairly unreasonable to ask for any further explanation of the acute, infectious diseases. The germs were relegated to the more humble function of poison-factories, and the ptomaines were invested with the insignia of malevolent power. The pendulum seems disposed to swing back germward now, and in this paper, which is preliminary to the record of some experimental studies made by Dr. Hodenpyl and the writer, and shortly to follow, on the tubercle bacillus, it is my purpose briefly to review a series of recent studies on the germ-cell bodies which throw a curiously interesting new light on some old body-cell problems.

A very curious vital phenomenon which has long been known in certain unicellular organisms—such as the fresh-water amœba and in the leucocytes of both the cold and warm-blooded animals—is their response by movement to contact with solid substances. Thus the amœba floating free in fluids tends to assume a spheroidal form and to remain immobile. When, however, under suitable conditions, it touches a solid surface, like that of a glass slide, it sends out pseudopodia and performs those curious progressive evolutions known as the amœboid movement. Essentially, the same series of movements is observed in leucocytes when they, under favorable conditions, come in contact with solid surfaces—such as a glass slide or the walls of the body lymph-spaces. This faculty in these primitive forms of life, consisting of a simple lump of protoplasm, is called *tactile sensibility,* and it is in virtue of this that many of the remarkable and useful evolutions of the leucocytes in the body transpire.

It was found by Pfeffer (1), a good while ago, that some of the lowly vegetable organisms endowed with locomotion —the *flagellata, bacteria,* etc.—were capable of moving toward or away from certain substances which exerted a chemical action upon them. This property he designated as *chemotaxis,* and further postulated as *positive chemotaxis* the attracting effect, and as *negative chemotaxis* the repelling effect, on such organisms of the chemical substances.

Pfeffer has shown that mobile bacteria move toward nutrient substances, such as beef-tea, and Engelmann and others (2) have demonstrated their movement toward oxygen. both effects being apparently due to the positive chemotactic action of these substances. Stahl (3) showed that similar properties exist in the plasmodia of myxomycetes. This movement has been proved to be due, not to currents in the fluids, not to diffusion, but to the specific action of the particular chemical substances in question on living organisms.

The chemotactic powers of the juice of raw potatoes, which contains, as Pfeffer showed, potash salts and asparagin, has been used in capillary tubes by Ali Cohen (4) to separate mobile from immobile bacteria in mixtures. In this way he found that he could separate cholera and typhoid bacilli from the numerous other forms in the fæces, and thus make easier the obtaining of pure cultures for diagnostic purposes.

Now, the same condition of affairs exists in the leucocytes of both the cold-blooded and warm-blooded animals, and the conditions and bearings in them of this positive and negative chemotaxis were studied in detail by Massart and Bordet (5) and by Gabritchevski (6) in 1890. The latter observer has grouped as the result of his experiments certain chemical substances in accordance with their action in this way upon leucocytes. Thus, in the group of substances exciting a negative—repelling—chemotaxis, we have concentrated salt solution, 10 per cent.; lactic acid; quinine, 0.5 per cent.; alcohol, 10 per cent.; chloroform; jequirity; glycerin; bile. Substances having no effect—indifferent chemotaxis—are distilled water; dilute salt solution, 0.1 to 1 per cent.; carbolic acid, 1-per-cent. solution; antipyrine; glycogen; peptone; beef-tea; blood; aqueous humor. Among the most prominent substances exciting a positive chemotaxis are especially sterilized and non-sterilized cultures of various pathogenic and non-pathogenic bacteria.

The general method of testing the powers of these various substances is to fill small capillary glass tubes, closed at one end, with the substance to be tested, and to thrust these beneath the skin of an animal. After a few hours these tubes are withdrawn and their contents examined. Into tubes filled with substances inciting positive chemotaxis the leucocytes crowd in great numbers, while they are held away from tubes having negative chemotactic contents, and when filled with indifferent substances there is no effect at all. While the tactile sensibility of leucocytes may cause them to cluster in small numbers about the surface of the glass tubes, the effect of this property in the leucocytes is altogether insignificant as compared with the chemical substance exciting positive chemotaxis.

It appears, then, that there are certain substances associated with bacteria which excite in the leucocytes a movement toward the germs. The culture medium itself has no such effect, but the action is developed equally whether the cultures be living or have been killed by boiling. It would thus appear that either the bacteria themselves or some result of their life and growth must be the exciting agency.

Under the dominant views regarding the significance of the various chemical substances set free by bacteria as they grow, it has been assumed that it was largely under the exciting influence of the ptomaines that leucocytes exhibited the phenomena of chemotaxis in the presence of bacteria. A practical bearing was given to the subject, under the influence of this view, by the assumption that in the process of suppuration, as commonly induced by various species of bacteria, the leucocytes gathering at the inflammatory foci were drawn thither in virtue of their chemotactic properties which the metabolic bacterial poisons brought into play. To this view the doctrine of phagocytosis, as held by Metschnikoff and his adherents, readily attached itself, and we had a well-rounded hypothesis, in accordance with which the leucocytes, drawn, in virtue of their chemotaxis, into the vicinity of invading bacteria, at once set to work to destroy them, and with them the poison sources which were stimulating excessive cell inroads.

But, while these observations were going on, an allied but quite independent series of experiments was being carried out by Buchner and his associates in Munich, which have thrown a new and apparently most significant light upon both the phenomena of chemotaxis and the nature of suppuration. To these experiments let us then briefly turn.

While it is fully established that a true suppurative inflammation may be experimentally induced by a variety of inorganic substances, it is still true that the suppurative processes which occur in the body, either as independent lesions or as complications of a variety of diseases, are practically always due to the action of bacteria. So that in a clinical sense the summary statement, "no suppuration without bacteria," is true. While, as above indicated, it has been the general belief of late that the metabolic products of bacterial life, the "ptomaines" or the "toxines," were the active agents in inducing suppuration, this, save in a few instances, has not been proved.

Buchner (7), in the course of some experiments on the introduction of anthrax spores and anthrax bacilli into the trachea of rabbits and guinea-pigs, had observed some time ago that while the introduction of the bacilli was followed by an intense inflammatory reaction of the lung tissue, with accumulation of leucocytes, fibrin, etc., in the air spaces, the introduction of the spores alone was followed by no such marked inflammatory reaction, but that the spores entered the blood channels and induced, in due time, the usual systemic effects of anthrax poisoning.

There is one factor—so reasoned Buchner—which has not been taken definitely into account in the causation of suppurative inflammation by bacteria, and that is the possibility that the effect may be produced, not by the ptomaines, not by the toxines already so much studied, but by the albumenoid constituents of the bacteria cells themselves. If this were true, then the intense exudative inflammation in the lungs following the introduction of the anthrax bacilli might be explained by the local disintegration of the bacilli and the setting free of their potent proteid constituents, while no such effect would follow the introduction of spores.

It has been repeatedly shown by numerous observers (8) that sterilized cultures of various pyogenic bacteria—such as *staphylococcus pyogenes aureus*, *bacillus pyocyaneus*, etc.—

were as capable of producing suppuration as were the fresh living cultures. But it was believed that this was due to the retention of a toxic substance furnished by the life processes of the germ which had not been destroyed by the sterilization, but clung about the dead germ bodies. Although Wyosokowitsch had filtered off the fluid from sterilized anthrax cultures and found that the filtrate was not pyogenic, while the solid material was, he inferred only that the toxic material assumed to cause suppuration was not soluble in the nutrient fluid.

Buchner had also shown (9), in the course of some other experiments, that the sterilized emulsion of the so-called pneumo-bacillus of Friedlander, subcutaneously injected, could cause suppuration in rabbits and guinea-pigs. He found further that if such a sterilized emulsion were allowed to stand for some time, so that the solid could be separated from the fluid parts of the mass, the fluid part did not cause suppuration, while the solid part did. That the effect of such sterilized bacterial emulsions was not due to their mechanical effects in the tissues was shown by such control experiments as the introduction of powdered charcoal, infusorial earth, magnesia, potato emulsion, etc., beneath the skin, with negative results.

By a series of manipulations similar to that practiced with the pneumo-bacillus, Buchner now tested the effect of sterilized emulsions of cultures of seventeen different species of bacteria, among which may be mentioned *staphylococcus pyogenes aureus, staphylococcus cereus flavus, sarcina aurantiaca, bacillus prodigiosus, bacillus fitzianus, bacillus cyanogenus, bacillus megatherium, bacillus subtilis, bacillus coli communis, bacillus acidi lactici, bacillus anthracis, proteus vulgaris, Finkler's comma bacillus, etc.* The injection of one cubic centimetre of the sterilized emulsions of each of these germs resulted within two or three days in an aseptic—that is, bacteria-free—purulent infiltration in the subcutaneous tissue at the seat of injection. On the other hand, the clear fluid obtained by sedimentation from the sterilized emulsions of *bacillus cyanogenus, bacillus megatherium* and *bacillus anthracis* induced no suppuration while the separated sediment invariably did.

While it thus seemed probable that the albuminous material of the bacterial cell was at least chiefly concerned in inducing suppuration on the injection of sterilized emulsions, this was not yet fairly proved. Buchner now sought to strengthen the evidence by a very ingenious experiment. The modern technique of staining bacteria with the aniline dyes depends, as is well known, upon the power of these dyes to enter into chemical combination with the bacterial cell plasma. Acting upon this principle, Buchner found that if he added to a sterilized emulsion of the pneumo-bacillus, which was strongly pyogenic, an aqueous solution of methyl violet, the emulsion was wholly bereft of its pyogenic powers. Anent of this interesting bit of evidence of the importance of the bacterial cell proteids, Buchner calls attention to its bearing upon the theory of the antiseptic and antipyogenic action of the so-called pyoktanin of Stilling, the usefulness of which in practice is still *sub judice.*

But more definite proof of the importance of the bacterio-protein in inducing suppuration was still needed and Buchner proceeded to separate it from cultures of the pneumo-bacillus after the method of Necki, by digestion of masses of culture in dilute potash and precipitation with acetic or hydrochloric acid. The precipitate separated by filtration was again dissolved in dilute potash solution and reprecipitated. This was done the third time, and at last the purified product was brought into solution. This material gave the chemical reaction of an albumenoid body. Subcutaneous injection of this material in rabbits in some cases was followed by a gathering of leucocytes, in others not. As it seemed likely that on simple subcutaneous injection the material was readily and rapidly absorbed before it produced local effects, recourse was had to a method of experiment used by Councilman in his well-known studies on suppuration (10). Small glass tubes, drawn out at the ends, were filled with pneumo-bacillus protein, sealed up, and sterilized by steam for an hour. These were then introduced, with strict antiseptic precautions, beneath the skin of rabbits, shoved away from the opening, and, after they were healed in, their tips were broken off. After five days the tubes were exposed. Around the openings of these, as well as extending deep into their interior, were masses and plugs of leucocytes. Cultures showed no living bacteria. Control experiments with tubes filled with salt solution showed no collection of leucocytes.

It thus seemed to be proved that the pyogenic action of sterilized cultures of Friedlander's pneumo-bacillus is due to the freed albumenoid constituents of the bacteria cell. That such a freeing of the contents of the bacterial cells occurs in the tissues of the living body seems evident from their well-known proneness to disintegration and the development of involution forms in suppurative foci.

The next thing to be done was to carry on a similar series of experiments with other well-known pathogenic bacteria. To this task Buchner and his associates addressed themselves in a series of studies as yet not fully published (11). But, even so far as their results are known, some most significant facts have been elicited. Buchner endeavored to separate by the method of Necki (see above) the bacterio-protein from about fifteen species of bacteria, but in many of these the attempt was unsuccessful, because sufficient solution and extraction of the proteid ingredients of the germs did not occur. The *bacillus pyocyaneus* gave the most abundant albuminous extract, but a sufficient amount was obtained from *staphylococcus pyogenes aureus, bacillus typhosus, bacillus subtilis, bacillus acidi lactici,* and from the red potato bacillus for animal experiment. It was, in fact, found that capillary tubes filled with the purified proteids from all these species of bacteria and placed beneath the skin of the rabbit showed after two or three days, extending into the open end, a plug of fibrinous pus several millimetres in length. This plug was found, on microscopical examination, to consist largely of leucocytes.

That the ordinary chemical decomposition products of bacterial cell life are not concerned in inducing this positive chemotaxis in the leucocytes was shown by introducing beneath the skin of rabbits tubes filed with such substances as butyrate and valerianate of ammonia, trimethylamin, ammonia, glycocoll, leucin, tyrosin, urea, etc. These were, for the most part, wholly without effect upon the leucocytes, only glycocoll and leucin exciting in some cases a moderate chemotaxis, not at all to be compared, however, with that of the bacterio-proteins.

It would thus seem to be highly probable, if not absolutely proved, that the power of exciting positive chemotaxis, which at least many species of bacteria display, is due to the proteid ingredients of their bodies when these are set free, as they may be naturally when the germs disintegrate in the tissues, or artificially by chemical extraction.

With that keenness and fertility of thought which characterizes Buchner's work, he now gave wider range to his investigation. He recognized the fact that, though of late the phagocytic action of the leucocytes has been especially emphasized in relation to bacteria, this is by no means their chiefest or most constant *role.* Dispose of bacteria, the leucocytes undoubtedly do ; whether after themselves killing them, or after they are destroyed by other agencies, has not yet been fully determined. But by far the most constant phagocytic *role* of the leucocytes is in carrying on the process of resorption and disposal of useless particles and dead material in the living body. About such material they gather much as they do in the vicinity of bacteria, though not in such marked degree or under such dramatic conditions.

Now, what attracts the leucocytes into the vicinity of a particle of dead and useless muscle, or cartilage, or connective tissue which they are to absorb and remove ? Certainly not bacterial poison, certainly not bacterial proteids ; for with what may be called the normal phagocytic functions of the leucocytes bacteria having nothing to do. Having shown that a proteid substance derived from the bacterial cells was capable through chemotaxis of attracting leucocytes, Buchner now studied in a similar way the effects of closely allied substances—namely, the so-called vegetable caseins, gluten casein from wheat and legumin from peas, both separated by precipitation from alkaline solutions. Both of these substances were capable of exciting the most marked chemotaxis in the leucocytes of rabbits. Moreover, as it has been shown that vegetable casein exists as such in the grain of cereals and of the leguminosæ, he introduced beneath the skin of rabbits or guinea-pigs, under strict antiseptic precautions, masses of wheat and pea meal, and found that within two days these masses were surrounded and penetrated by enormous masses of leucocytes. Cultures from these masses proved the entire absence of bacteria. Starch introduced subcutaneously under the same conditions induced no gathering of leucocytes.

That this gathering of leucocytes was due to chemotaxis and not simply mechanical, owing to the tactile sensibility of the leucocytes, was shown by introducing subcutaneously in a rabbit in one place an emulsion of infusorial earth with 0.7-per-cent. salt solution, and in another place an emulsion of the earth with gluten casein. In the first, after three days, but few leucocytes had gathered about the foreign material, while the second was surrounded and partially penetrated by an enormous number of leucocytes.

But still another step remained to be taken. As the gathering of leucocytes about dead organic fragments in the tissues which are to be removed, as so often happens, cannot be ordinarily due to bacteria or bacterio-protein, so, also, interesting as the observation may be, can vegetable proteins have no part in the matter. So alkali albumenates were prepared and purified, in a manner similar to that employed with the bacterial and other vegetable proteins from muscle, liver, lungs and kidneys of rabbits. These tested in the same way were all found to strongly attract leucocytes when introduced beneath the skin in tubes. Of the alkali albumenates prepared from blood, fibrin, yolk and white of egg, only the blood and yolk of egg showed moderate power of exciting positive chemotaxis,

These experiments show that it is only certain of the decomposition products of animal tissue which possess chemotactic powers, and that these, as a rule, are the earlier and not the ultimate products of the decomposition.

Finally, as it has been shown that a general leucocytosis is apt to be associated with febrile inflammatory processes. Buchner and Roemer studied the effects of intravenous injections in rabbits of these various chemotactic proteids. They found that within eight hours of their introduction into the blood there was a marked leucocytosis lasting for several hours, and that this might be heightened by repeated injections. Thus they found, by a daily injection of 2 cc. of an eight-per-cent. solution of the bacterio-proteins of *bacillus pyocyaneus*, the relation of white to red blood cells, which at first was 1 to 318, was on the second day 1 to 126; on the third day, 1 to 102; on the fourth morning, 1 to 73; and on the same evening, 1 to 38. From this time on no increase was noted. The absolute number of the red blood cells remained unchanged, while there was an absolute sevenfold increase in the number of leucocytes. Gluten casein, as well as alkali albumenate from muscle, injected into the blood, showed similar but less pronounced effects.

Considering now the bearing of all these experiments on suppuration and on physiological resorption of the dead organic materials in the tissues, it would appear that in simple resorption, as in bacterial suppuration, the leucocytes are drawn to the seat of operation by a proteid material. This in resorption seems to be furnished by the dead and disintegrating tissues themselves, and when the leucocytes have gathered up a certain amount of refuse in their bodies they may carry it away. In bacterial suppuration, on the other hand, the attracting material may be furnished by the protein of the disintegrating bodies of the bacteria themselves, but poisonous ptomaines furnished by the live bacteria may cause the destruction and degeneration of the attracted leucocytes, which thus collect as pus.

Whether the ptomaines themselves may not indirectly furnish chemotactic material by causing the destruction of the tissue elements and the setting free of their albuminous constituents, is a matter requiring further study.

It is also not improbable that the limited suppuration induced by bacteria-free chemical substances—such as turpentine, calomel, etc.,—may be due. to the chemotactic tissue-proteids set free by the action of the chemicals on these tissues.

It seems probable that not only are the leucocytes drawn toward the chemotactic proteids thus produced in or introduced into the body, but that the fixed connective-tissue cells are stimulated to proliferation. In fact, Buchner found that by the introduction of a sterilized emulsion containing 3.5 milligrams of pyocyaneus protein into the forearm of one of his associates, a severe inflammation was induced with all the symptoms of an acute typical erysipelas, with lymphangeitis, such as must have involved the fixed connective-tissue cells. On the fourth day the inflammatory process underwent resolution. Gluten-casein induced similar but less acute effects.

These most clever and striking researches of Buchner would seem to throw much light on the whole subject of the theory of suppuration, and to promise large accessions to our knowledge of inflammation when the many lines of thought and study which they suggest shall have been followed out.

It is now evident that an *aseptic suppuration* is possible under a variety of conditions.

It still remains true, however, for the purposes of surgical practice, that the suppurative processes as we see them in the clinic and at the bedside are due to the presence of bacteria of one form or another. It is true, also, that the suppurations which we can induce experimentally with sterilized—that is, dead—bacterial cultures, or with certain dead proteid substances—aseptic suppurations—are limited in their duration, extent and destructive power, as compared with those occurring under the influence of living germs. This is because in the latter case the growing and new forming germs may keep up the inflammation once alight to an almost indefinite extent.

We purpose, in the paper which is to follow, to detail some results of a series of experiments on the action of dead tubercle bacilli on the living tissue not less striking than are those which show the power of other sterilized bacteria to induce suppuration.—*New York Medical Journal.*

THE CHEMICAL FACTORS IN THE CAUSATION OF DISEASE.

LECTURE DELIVERED AT THE POST-GRADUTE MEDICAL SCHOOL OF CHICAGO
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LECTURE I. GENERAL CONSIDERATIONS OF THE RELATION OF BACTERIAL POISONS TO THE INFECTIOUS DISEASES.

The majority of diseases may be grouped, from an etiological standpoint, into the following classes: *First,* traumatic; *second,* infectious; *third,* autogenous, and, *fourth,* neurotic.

It must be understood, however, that in many diseases the cause is not single, but multiple, and for this reason sharp lines of classification cannot be drawn. For instance, the greatest danger in those traumatic affections in which the traumatism itself does not cause death, lies in infection. The wound has simply provided a suitable point of entrance for the infecting agent. Indeed, the break in the continuity of tissue may be so slight that it is of import and danger only on account of the coincident infection. This is true in many cases of tetanus. Furthermore, an infectious disease, whether it originates in a traumatism or not, is markedly influenced by what we are pleased to call the idiosyncrasy of the patient, and by which we mean the peculiarities of tissue metabolism taking place in the individual at the time. A dozen men may be exposed alike to the same infection, and the infecting agent may find a suitable soil for its growth and development in two of these, while in the other ten this same agent meets with such adverse influences that it dies without producing any appreciable effect; or all may be infected, but with differences in degree, as is evidenced by variations in symptoms, in the length of time that the infecting agent continues to grow and develop in the body, and in the ultimate result. Every physician who has had experience in the treatment of typhoid fever, diphtheria, scarlet fever—or, in short, of any of the infectious diseases—will appreciate the importance of the personal equation in his patients. That some neurotic affections originate in traumatism, we know. That others of this class are largely due to malnutrition accompanied by improper metabolism or insufficient elimination; or, in other words, are to some extent autogenous, all believe. Understanding, then, that the above classification does not attempt a sharp and marked differentiation of the causes of disease, I wish to devote the first two of the three lectures, which you have kindly asked me to give, to a consideration of the chemical factors in the causation of the infectious, and of the traumatic, autogenous and neurotic diseases in so far as these are influenced by infection.

The science of bacteriology is now entering upon a new and promising era in its development. Heretofore, this science has been largely founded upon morphological studies. Bacteriologists have given their time and attention to the discovery of bacterial forms in the diseased organism, and to the observation of characteristics in structure and growth of different species of bacterial life. The question, Do certain germs have a causal relation to certain diseases? having been settled in the affirmative, the next question which naturally arises is, In what way is this causal effect accomplished? How do germs prove harmful? To this question, a number of answers have been proposed. But as I have elsewhere* discussed these theories, I will not repeat them here. Suffice it to say that it is now generally admitted that the deleterious effects wrought by germs are due to chemical poisons elaborated by them during their growth. Granting this, it will be at once seen that the morphological study of germs, important as it is, becomes wholly inadequate in ascertaining their true relationship to the diseases with which they are associated. We must now study the physiology and the chemistry of germs, and until this is done we must remain ignorant of the true cause of disease, and, so long as we remain ignorant of the cause, it cannot be expected that we shall discover scientific and successful methods of treatment. Suppose that our knowledge of the yeast plant was limited to its form and method of growth, of how little practical importance this knowledge would be. That the yeast plant requires a saccharine soil before it can grow, and that given such a soil it produces carbonic acid gas and alcohol, are the most important and practical facts which have been ascertained in its study. Likewise, the conditions under which pathogenic germs multiply and the products which they elaborate in their multiplication must be ascertained before their true relationship to disease can be understood.

In saying that the morphological work upon which the science of bacteriology rests almost wholly is inadequate, I wish that it may be plainly understood that I am not offering any hostile criticism upon the great men who have done this work and who have formulated conclusions therefrom. The development of bacteriology has been in accordance with the natural laws governing the growth of all the biological sciences.

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* Ptomaines and Leucomaines.

The study of form naturally and necessarily precedes the study of function. The ornithologist finds a new species of bird. He first studies its shape and size, the color of its plumage, the form of its beak, the number and arrangement of the feathers of the tail and wing, the color of the eyes, etc. All this he can do with a single specimen, recognizing the fact, however, that variations, more or less marked, are likely to be found in other individuals. More time and wider opportunities of observation will be needed before he can tell where and when this bird is accustomed to build its nest, upon what insects, grains and berries it feeds, with what other species of birds it lives in peace and with what it is at war. A much greater range of observation and study is necessary before the naturalist can tell how his newly discovered species would thrive if carried to a new climate, where it would be compelled to live upon unaccustomed food, to build its nest of strange material and to encounter new foes. I repeat that it is no discredit to the science nor to the men who have developed it, to say that the study of bacteriology has hitherto been almost wholly morphological; without the morphologist, the physiologist and the physiological chemist would not exist. The science having had for its support only morphological studies, the deductions and formulated statements arrived at by its students have been reached in accordance with the knowledge obtained from this source. But now, it being admitted that the causal relation between a given germ and a certain disease is dependent upon the chemical products of the growth of the germ, the fundamental lines of work must be altered in order to correspond with this new knowledge. Let us inquire into the changes, which the introduction of this new factor must make in our fundamental conceptions of the causal relation between germs and disease.

The four rules of Koch have been generally conceded to be sufficient to show that a given germ is the *sole* and sufficient cause of the disease with which that germ is associated. Briefly these rules are as follows :

First. The germ must be found in all cases of this disease.

Second. The germ must be separated from other organisms and from all other matter found with it in the diseased animal.

Third. The special bacterium thus freed from all foreign matter must, when properly introduced, produce the disease in healthy animals.

Fourth. The micro-organism must be found properly distributed in the animal in which the disease has been induced.

Let us give our special attention to the first of these rules for a few moments. What is meant by the statement that the special germ must be found in every case of the disease? How will A, pursuing his studies on the bacteriology of a given disease in America, decide whether or not a bacillus, which he finds, is identical with one which has been reported as invariably present in the same disease, by B, who has investigated an epidemic in Germany? What means are relied upon to prove the identity of these two organisms? The means which have been relied upon wholly are the form, size, reaction with staining reagents, manner of growth on the various nutrient media, and, in exceptional instances, correspondence in their effects upon the lower animals. In other words, with the exception of those instances in which the effects upon animals are tried, the characteristic, by which the germ causes the disease, is left wholly out of consideration.

Indeed, some of the most eminent bacteriologists have taught that in the identification of germs the reactions with staining agents and the appearances of the growths on the various nutritive media are of more importance than the observation of the effects upon animals. Thus, Fluegge says:

> "Inoculation experiments with both typhoid dejections and pure cultures of the Eberth bacillus have universally been without success. The few experiments in which a typhoid disease has followed inoculation or feeding have been made with impure material containing other active bacteria. It is known that a group of widely distributed organisms, which, however, are wholly different from the typhoid bacillus, have the power, when injected subcutaneously or intravenously, of producing in animals death with marked swelling and ulceration of Peyer's patches. To these organisms undoubtedly are due the apparently positive results which some authors have supposed to be due to inoculation with the typhoid bacillus."

In other words, this eminent author teaches that, although other germs may cause the essential symptoms and lesions of typhoid fever in the lower animals, they are not related to the germ found in the spleen of man after death from typhoid fever, because they do not react in the same manner with the aniline stains.

Bacteria cannot be classified so far as their causal relationship to diseases is concerned (and this is the most important knowledge to be gained from them) until we know the nature of the chemical poisons which they elaborate, for it is by virtue of these poisons that they have any causal relationship to disease.

It is possible that two germs may be unlike in form, and yet they may produce poisons which are identical or those which are very similar in their effects upon man. One germ may be stained by Gram's method and another fail to be acted upon when so treated, but this does not prove that their chemical products are totally unlike.

We will suppose that in an epidemic of diphtheria A examines the membrane from a hundred, or we might as well suppose a thousand, children and finds a characteristic, well-marked, easily recognized bacillus in all. He isolates this organism and obtains it in pure culture. He inoculates animals and these manifest all the signs together with the appearance of the characteristic membrane of diphtheria, and in these animals he finds his bacillus growing as in the throats of the children. All of the rules of Koch have been complied with. Has A demonstrated that his bacillus is the *sole* cause of diphtheria? No. He has shown that his bacillus is *a* cause of diphtheria, but he has not proven that there may not be other germs, wholly different from his in form and size, which may also cause diphtheria. The most which can be proven by Koch's rules is that a given germ is *a* cause of the disease. They do not show, as most bacteriologists would have us believe, that this germ is the *sole* cause of the disease.

To illustrate, we will suppose that a botanist in visiting Arabia should find a tree producing a berry, the coffee berry, which when properly prepared and taken into the system produces certain effects. These effects are due to the alkaloid caffein, and our supposed discoverer finds that they invariably follow the drinking of a decoction of these berries. Would he be justified in concluding that the coffee tree is the only plant in the world capable of producing these supposed characteristic effects? Should he reach such a conclusion, the fact that it is not warranted would be shown by a study of the tea plant in China and the guarana of South America.

What is meant in the first of Koch's rules by the statement that the germ must be present in all cases of the disease? In answering this question, I will give two specific illustrations showing the manner in which eminent bacteriologists have applied this rule. This is well shown in the bacteriological literature of typhoid fever and diphtheria.

Eberth found the bacillus, which is now generally considered by bacteriologists as the sole cause of typhoid fever, in eighteen out of forty cases. In the examination of twenty-eight bodies dead from typhoid fever Gaffky found the Eberth germ in twenty-six; Fraenkel and Simonds reported in twenty-five out of twenty-nine cases; Seitz in twenty-two out of twenty-four; Rietsch in thirty-five out of thirty-six; and Kowalskski found it present in each of twenty-nine cases. From these and similar reports, bacteriologists have concluded that this germ is not only *a* cause, but the *sole* cause of typhoid fever. Are they justified scientifically in this conclusion? Have they any right to say that there is no other germ in existence which may cause typhoid fever? The speaker has shown that there are at least two other germs which induce the same symptoms in a more intensified form in the lower animals, and has isolated and studied the chemical poisons of these germs, and recenty Babes has shown that in the examination of twelve persons who died at Bucharest of typhoid the Eberth germ was not present, and that an organism giving quite different reactions was present.

Loeffler and other German investigators have shown the presence of a bacillus in the majority, not in all, of the cases of diphtheria which they have studied, and they again conclude that this bacillus is not only a cause but the *sole* cause of the disease. In a large number of cases in New York, Prudden failed to find the Loeffler bacillus, but did find a wholly different organism. No one acquainted with Prudden's work will question the accuracy and care with which it was done. It is true that the chemical poisons of the Loeffler bacillus have been studied, and no one can doubt that it is a cause of diphtheria, but it may be found that the streptococcus of Prudden is capable of elaborating a similar poison.

The moment that it is granted that the real poison of the disease is chemical in character, it becomes evident that no one is justified in saying that one germ is the sole source of such a poison. Such a statement would be as much unwarranted as one that the coffee tree is the sole source of caffein, or that the *strychnos ignatii* is the only species of the natural order *loganiaceæ* which produces a convulsive poison. In other words, the specific cause of a given disease is not to be determined wholly by the morphology of the germ found associated with that disease in a given epidemic, but by the character of the chemical poison which is the true *materies morbi.*

I think that we are justified in concluding that, in those diseases in which the four rules of Koch have been complied with, the germ is *a* cause of the disease, but our range of observation must be much wider than it now is, before we can say that the given germ is the *only* cause of the disease. It may be found, and I think this highly probable, that those few infectious diseases, such as anthrax and tuberculosis, which have such well-marked typical clinical histories, are due to equally well-marked and morphologically distinct micro-organisms which can be recognized by microscopical study alone ; but I do not expect that this will prove to be true in diseases showing such wide variations in symptoms as is done by typhoid fever and cholera infantum. In fact I am convinced that these last-mentioned diseases may and do result from any one of a number of bacteria which are in form, size, methods of growth and reactions towards staining reagents quite distinct one from the other, but which produce poisons similar in their effects.

That you may be convinced of the truth of the foregoing statements I give a few specific instances which will confirm them, and demonstrate that, in their causal relation to disease, germs cannot be classified from a study of the form, size, methods of growth and reactions with staining reagents.

TYPHOID FEVER.—Eberth lays special stress upon the fact that his germ does not take the ordinary stains readily, and says that it is not colored by Bismark-brown and hæmotoxylin, and only slightly by the other ordinary stains; but what is the verdict of others on this point? In the paper in which he calls attention to the fact that he has photographed the short bacillus before Eberth had published his discovery, Koch says: "Eberth states that these short bacilli have but slight tendency to take stains. The photograph here given shows, to the contrary, that in taking stains these bacilli are but slightly inferior to other bacteria." Gaffky states that the best coloring agent is methyl-blue, that the bacilli are stained very well with methyl-violet, gentian-violet, Bismark-brown and fuchsin, and less well by hæmotoxylin. Coates had no difficulty in staining with Bismark-brown. Meyer had the same difficulty as Eberth in staining; but Friedlander found that the bacilli in sections from the spleen stained intensely. In view of this variety of statement, can anyone claim that these men were working with a germ which can be distinguished from others by its tinctorial properties?

TETANUS.—The tetanus germ of Kitasato and that of Tizzoni and Cattani are known to be quite distinct. Cultures of the former in bouillon are virulent, while those of the latter in the same medium are inert. Not only are these two organisms morphologically and biologically different, but their poisons are chemically unlike. Brieger and Fraenkel precipitated the poisonous albumen of the germ of Kitasato with alcohol, but this reagent renders the poison of the Italian germ inert. Notwithstanding this difference, however, both micro-organisms and their chemical products produce tetanic convulsions and death in the lower animals. We must, therefore, admit that there are at least two distinct germs, each of which is capable of causing tetanus, and how many other bacteria with like properties there may be no one can tell.

THE SUMMER DIARRHŒAS OF INFANCY.—In this class of diseases all attempts to find a morphologically specific germ have failed. The labors of Booker in this country, and of Escherich in Germany, have shown that no one species or variety is constantly present. No less than thirty distinct germs have been obtained from the bowels and fæces of children suffering from the summer diarrhœas. A germ which is frequently present one season will not be found at all the next. Are we to conclude from this failure to comply with the first of Koch's rules that the summer diarrhœas of infancy are not due to micro-organisms? Certainly not; especially in view of the fact that Baginsky and Stadthagen have shown that the bacillus discovered by Baginsky produces a chemical poison which induces diarrhœa in the lower animals, and I have shown that at least three of Booker's bacteria produce poisons which have similar effects. To the contrary, we are justified in concluding that the diarrhœa may be due to any one or more of a number of germs which differ from one another sufficiently morphologically to be classified as distinct species. The similarity among these bacteria will not be discovered by a study of their size, form and reactions with staining reagents, but by a study of their chemical poisons, the agents by virtue of which they cause the disease. At the meeting of the American Medical Association at Newport, in 1889, I proposed, in a paper on the etiology of typhoid fever, that in those cases in which the lower animals are not available, on account of their insusceptibility, before a given germ can be considered a cause of a disease, it must be shown that that germ can produce chemical poisons which will induce in the lower animals, in an acute form, the characteristic symptoms of the disease. That this rule would be a wise one I have become, even more strongly than I was at that time, convinced.

In the little volume on "Ptomaines and Leucomaines," written by Novy and myself, and published in 1888, I gave the following definition of an infectious disease: "An infectious disease arises when a specific, pathogenic micro-organism, having gained admittance to the body and having found the conditions favorable, grows and multiplies, and in so doing elaborates a chemical poison which induces its characteristic effects."

It should be remembered that this definition was written at a time when the importance of the chemical products of bacterial growth was not generally recognized. Indeed, at that time bacteriologists quite universally held to the mechanical interference theory, and more than a year later so good an authority as Welch, of Baltimore, stated that a knowledge of the chemical products of bacteria was interesting but not essential to a belief in the causative agency of a micro-organism, and he went still further, inasmuch as he claimed that the successful inoculation of animals is not necessary in order to prove the causal relationship of a certain germ to a given disease. Now, it is generally conceded that a successful inoculation is a proof of the formation of deleterious chemical products, and in case successful inoculation cannot be obtained on account of the insusceptibility of the lower animals, the demonstration of the elaboration of chemical poisons is deemed not only interesting but important. For instance, the strongest proof that the cholera bacillus of Koch has a causal relation to Asiatic cholera has been furnished by the study of its chemical products, and the similar studies of many of the other infectious diseases have yielded results which are of both interest and importance, as I shall endeavor to show in the next lecture.

The only modification which I desire to make in the above definition of an infectious disease consists of an elaboration of what is meant by a "specific" micro-organism. The specific nature of a germ is to be determined not by its size, form, growth on nutritive media and reactions with staining reagents, all of which properties are more or less variable with the conditions under which the germ has been grown, but upon its capability of producing within the body deleterious substances.

The study of the chemical factors in the causation of the infectious diseases opens up for us a field in which much work must be done. Let us attempt a statement of the nature of some of the researches that must be carried out along this line.

In the first place we must ascertain what germs are toxicogenic. This would necessitate a chemical study of all kinds of bacteria, both the pathogenic and the non-pathogenic. Every fact learned in this investigation will not have its practical application in medicine, but will have its scientific value, and many will most probably be of more or less direct service to man. There is a vast field here for careful scientific work, and I should be glad to see these researches carried out largely in our own country.

Secondly, it must be determined under what conditions these germs are toxicogenic. It is not at all probable that all those bacteria which are capable of producing poisons when grown on dead material outside of the body are also capable of multiplication and the production of the same substances when under the influence of the various secretions of the body. Some bacteria are destroyed by a normal gastric juice within a short time, while others are not. The conditions of life and growth are different when the infecting agent is introduced into the blood from what they are when infection occurs by the way of the alimentary canal. This is well recognized in the two forms of anthrax, one of which arises from inoculation through a wound and the other by way of the intestines. A preventive treatment which is efficient in the one is of no service in the other. Then, again, we are to study those conditions of the blood and other fluids of the body, which are especially unfavorable to the successful implantation or the continued existence of an infectious disease.

Thirdly, the chemical properties and the physiological action of these poisons will demand careful attention. Some are especially depressing in their action upon the heart, others seem to manifest their energy upon the central nervous system, while others still act like true gastro-intestinal irritants. In the study of the toxicological effects of these bacterial poisons every method of investigation known in the most advanced physiological work must be employed. The action of these agents on the heart, the brain, the spinal cord, etc., must be thoroughly studied.

After all this has been done we shall certainly advance in our knowledge of the treatment of the infectious diseases. The morphological study of bacteriology has been of inestimable value to us in the prevention of the infectious diseases. It has rendered the investigation of disinfectants both possible and imperative, and by the knowledge thus gained yellow fever has repeatedly, and Asiatic cholera in one instance at least, been kept from our shores. Epidemics of small-pox, diphtheria and scarlet fever have been arrested. In this way scientific medicine has been advanced, and such an advance is never made without great benefit to mankind in general. Moreover, antiseptic surgery, which had already been inaugurated by the genius of Lister, has received the scientific support which was necessary to its constant, universal and correct employment. All of these benefits, and possibly more, which do not occur to me at this time, have been accomplished, and to Pasteur, Koch and the host of others who have rendered this possible, we should be and are grateful. But what can those of us who are engaged in the treatment of the infectious diseases say of the present condition of the practice of medicine ? As one of this number I am forced to admit that my successes are few and my failures many. Are we satisfied with the treatment which we now employ for tuberculosis, diphtheria, scarlet fever, typhoid fever and the other internal infectious diseases ? Do we treat these diseases with much more success than our fathers did ? They prescribed for their consumptive patient liberal food, cod-liver oil, and all the open air exercise possible. They never carried a Begeron hydrogen-sulphide bag, used a Weigert hot-air oven, or injected Koch's lymph ; but can we say that our successes are markedly more numerous than theirs ? Has the knowledge of germs aided us in the treatment of these diseases ? Do we to-day possess one germicidal agent which will destroy the bacilli of typhoid fever in the spleen of our patient and at the same time do no injury to the patient himself ?

For myself I am perfectly willing to acknowledge that I am not satisfied with my success in the treatment of the infectious diseases, and it seems to me that careful scientific study along the lines which we have been following to-night holds out sufficient encouragement to lead us to further study. Could we treat morphine poisoning before we knew anything of the chemical properties or the physiological and toxicological effects of this alkaloid ? Can we counteract or antidote the typhoid poison, before we know anything of its nature or its manner of action ? I do not mean to imply that it is the duty of each of us to become a chemist or to undertake physiological research. We need as much as anything else a closer study of these subjects at the bedside. The scientific methods of the laboratory should be carried into the wards of the hospital. The physiologist keeps the dog upon which he is making some important study under his own trained eye and trusts no one else with the observations. The patient with typhoid fever in the hospital ward is seen by his medical attendant once or twice during the day. The remainder of the time all observations must be made and records taken by a nurse, who is not only devoid of scientific training, but has so much work to do that but little time can be given to the individual patient. There is work enough in the study of the poisons of disease to employ the chemist, physiologist and clinician, and the greatest good can be secured only by the combined labors of all.

You may think it strange that, enthusiastic as I am about the importance of the study of the bacterial poisons, I have said nothing about the therapeutical uses to which some of them may be put, as evidenced by the introduction by Koch of his so-called lymph or tuberculin as a cure for tuberculosis. There may be valuable curative agents discovered among the products of bacterial activity, but I have never believed that a disease will be cured by the administration of the very poison which is causing the disease. I say I have never believed this, but I am open to conviction on this point, and take much interest in a study of the results now being reported from all parts of the world, as well as in my own observation of the effects of the proposed cure. So far, however, I have seen no sufficient reason for any change in my belief on this point.

(*To be continued.*)

THE BIOLOGY OF THE LANCEOLATE DIPLOCOCCUS.

[TRANSLATED BY H. W. LOEB, A. M., M. D., ST. LOUIS, MO.]

BY PIO FOA (Turin).

The diplococcus lanceolatus appears somewhat different if taken from an inflamed lung or from meningitic pus. The extraordinarily different frequency of occurrence of pneumonia and cerebro-spinal meningitis encourages the thought that the two diseases may differ from each other in the action of the micro-organisms. However, the writer was unable to obtain any change in the virulence by transplantation of the cultures.

Some little is observed, depending upon the course and age of the cultures. The strength of the virulence, therefore, depends upon the shorter or greater persistance of the cocci upon the inoculated part. Besides this, by the conjoined inoculation with the staphylococcus or with the proteus vulgaris the qualities of the pneumo-coccus may be given to the meningo-coccus.

The writer discusses further the differences in the anatomical results which occur in the organs of the body when they are inoculated with the meningo-coccus or pneumo-coccus.

THE HISTOLOGICAL CHANGES OF THE ORGANS IN DIPHTHERIA.

[TRANSLATED BY H. W. LOEB, A. M., M. D.]

BY BABES (Bucharest).

The writer describes the tissue changes in diphtheria, which entirely correspond to the description given by Oertel. So far as the relation of these changes to the Loeffler bacillus is concerned, the difficulty of interpretation proceeds from the fact that streptococci accompanying the bacillus of Loeffler, as well as other bacilli which are similar, though not identical, to those of Loeffler.

He mentions the remarkably great caryokinesis which is found in the diphtheritic inflamed membranes. On account of the chemical products of the diphtheria bacillus one can only very imperfectly produce the peculiar anatomical changes of diptheria, whereas the picture which is obtained by the inoculation of the bacilli is on the whole very identical to human diphtheria.

(*To be continued.*)

SCIENTIFIC GLEANINGS.

BACTERIAL POISONS.

BY VICTOR C. VAUGHAN.

Medical News ; Popular Science News.

The author sums up the present state of our knowledge on the above subjects as follows :

First. Man is attacked by the infectious diseases either through the alimentary canal or through the blood or lymph.

Second. The gastric juice is a physiological guard against infection by the way of the intestines.

Third. Additional guards against infection by the intestines are probably to be found in the absorbing cells of the stomach and intestines.

Fourth. Susceptibility to the intestinal infectious diseases is increased when, for any reason, these physiological guards are defective.

Fifth. All toxicogenic germs are dangerous when introduced into the intestines, and their capability of doing injury lies in their production of chemical poisons.

Sixth. Many of these poisons are proteid in character.

Seventh. These poisonous proteids most probably act by catalysis.

Eighth. In the splitting up of complex molecules into simpler ones, heat is liberated and fever manifests itself.

Ninth. The physiological guard against infection through the blood or lymph lies in the germicidal action of the proteids of these fluids.

Tenth. Susceptibility to infection through the blood or lymph is increased by impoverishment of these fluids.

Eleventh. We can continue to treat consumption and other systemic diseases by the employment of liberal diet, exercise in the open air, and constitutional remedies without being unscientific in our practice.

Twelfth. Filth, without being the bearer of a specific germ, is a cause of disease.

Thirteenth. Wherever man pollutes the soil about him, the air which he breathes, and the water which he drinks with his own excretions, there enteric fever will be found.

Fourteenth. In their causal relation to disease, germs cannot be classified without a knowledge of the chemical changes which they induce.

Fifteenth. While certain bacterial poisons can result only from the growth of certain germs, other poisons similar to one another in their action, though probably not identical, may result from any one of a number of organisms. In the former case we have such diseases as anthrax and small-pox, with their practically constant symptoms and well-marked course ; in the latter case we have such diseases as the summer diarrhœa of infancy and enteric fever, with their varying symptoms. —*Buffalo Medical and Surgical Journal.*

BACILLUS OF CHOLERA IN SOIL.

Prof. V. de Giaxa draws the following conclusions from his experiments with the cholera bacillus on soil. When the cholera bacillus enters a soil rich in common bacteria, even though it finds conditions favorable to its existence and reproduction, it rapidly succumbs in the struggle which takes place between itself and the other bacteria. The latter increase in number, and this increase is rendered possible as far as the deeper layers of the soil are concerned by the addition of nutrient material which agrees with them, and also modifies the condition of the ground.

Should the cholera bacillus enter in relatively large numbers a soil which is inhabited by a few ordinary bacteria, not only its preservation, but also its reproduction become possible, until an increase of the common bacteria takes place from the penetration of the soil by nutritive matters which enter along with the pathogenic bacteria.

MICRO-ORGANISMS OF THE HEALTHY STOMACH AND THEIR ACTION.

M. J. E. Abelous confirms the results of Pasteur and Duclaux relative to the action of microbes in the stomach, and the part they play in digestion. The microbes were taken from the author's stomach by washing it out after fasting. The usual precautions were taken to prevent external contamination, and the mouth and pharynx were previously washed out with sublimate. The microbes were cultivated on gelatin, peptonized and glycerined gelatin, potato, gelatinized serum, neutral and acidulated bouillon. The species isolated were *sarcina ventriculi bacillus pyocyaneus, bacterium lactis aerogenes, bacillus subtilis, bacillus mycoides, bacillus amylobacter, vibrio rugula,* and nine other species, which are distinguished by letters, A, B, C, etc. These include one coccus and eight bacilli. The chief facts about these are that their resistance to an artificial gastric juice is greatly in excess of the mean duration of digestion in the stomach, and that they are potentially anaerobic.—*Exchange.*

TECHNIQUE.

EXAMINATION OF WATER FOR TYPHOID BACILLUS.

Dr. Finklenburg (*Centralbl. f. Bakt. u. Parasitenk.*, Bd. ix, No. 9, 1891) points out that in examining water for typhoid bacillus the sediment should always be used as well as the water itself. In a certain village, N———, there was an outbreak of typhoid fever amongst the boys of the school, following a similar outbreak in a neighboring group of houses. There was found to be a dangerous proximity of the spring from which the water was derived to the closets in the schoolyard. Examining the water by the ordinary gelatine plate method, the author was unable to find any traces of the Eberth-Gaffky bacillus in any of his cultivations ; but on allowing the water to stand and making cultivations from the sediment, there appeared, among others, characteristic colonies, the bacilli of which, in staining and microscopic appearances, could not be distinguished from those of the typhoid bacillus.

The author considers that this examination of deposited matter should never be omitted, as he thinks that it is probable that many of the germs must be held mechanically suspended with the solid constituents in the water rather than free in the water itself, as these organisms are almost invariably introduced along with solid sewage or other organic matter. He thinks such examination is especially necessary wherever a search is made for pathogenic micro-organisms.—*Supp. British Medical Journal.*

*A REVIEW OF THE METHODS OF DEMONSTRATING THE FLAGELLA ON MOTILE BACTERIA WITH SPECIAL REFERENCE TO THE STAINING PROCESS.**

BY VERANUS A. MOORE, M. D.

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There is, perhaps, no element in the known structure of micro-organisms that is more difficult to demonstrate than the flagella of motile bacteria. Ehrenberg was among the first of the earlier investigators in this field to infer from the discovery of a vortical action in front of a large motile spirillum (*s. volutans*) that its movements were produced and controlled by a pair of fine flagella, one at each end of its spiral body. With the improved microscopical apparatus, Cohn (1) succeeded in demonstrating the presence of the supposed flagella on this spirillum, and his discovery was confirmed shortly afterwards by Dallinger, Drysdale, and others. This fact suggested the idea that all motile bacteria depended for their movement on similar motile filaments.

Dallinger and Drysdale (2), basing their work upon the fact that the minuter monads are provided with one or more flagella, turned their investigations to *bacterium termo* to determine whether or not there existed a flagellum or flagella on that bacterium. For this work a $\frac{1}{16}$ inch Powell and Lealand immersion lens were employed, and special care taken to secure the best possible illumination. The specimen examined was prepared by adding a bit of culture of the bacterium termo grown in Cohn's nutritive fluid to a drop of distilled water on a slide and covering it with an extremely thin cover glass. The examination was continued incessantly for nearly five hours, when a flagellum was distinctly seen at one end of each of two termo that were moving slowly across the field. The flagella, as seen on the moving germs, were exquisitely delicate and constantly lashing. Other large motile bacteria were subsequently found to possess similar flagella.

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* Read before the Washington Microscopical Society, February 20, 1891.

The difficulty in detecting the flagella on motile bacteria in a fresh condition is well illustrated by the above briefly-described experiment. It is also a fact worthy of note that the flagella have been seen by this process only on the larger saprophytic forms, and that the smaller and especially the pathogenic germs could not be considered as possessing flagella, except from analogy, until other methods had been devised.

Dr. R. Neuhauss (5) reports a successful demonstration of the flagella on the comma bacillus by means of photography. A culture of this bacillus in meat broth was allowed to grow for four weeks, when it showed, instead of the ordinary delicate comma bacilli, large, thick bacilli and long spirilla. Most of these had lost their motility, but a few germs were still capable of movement. A preparation was made by adding a small quantity of this culture to a drop of distilled water on a slide and covering it with a thin cover glass. In this condition they were photographed, and a negative obtained which showed a delicate spiral flagellum attached to a short, much-curved bacillus. Other successful negatives were also obtained from the same field by focusing.

It is, however, through the development of staining methods that the demonstration of these hair-like appendages on the great majority of motile bacteria has been made possible, and, in many instances, comparatively simple. The discovery of a process by which these minute structures could be stained was first made by Koch, who, after a long series of negative experiments made with the ordinary dyes employed in staining bacteria, finally succeeded in staining the flagella on a certain number of saprophytic forms by using a solution of the extract of logwood. Since then other methods have been devised for staining the flagella on pathogenic as well as saprophytic bacteria, so that now we are able to demonstrate their presence on nearly all known motile germs. The development of these methods has been attended with much interest for each step in advance has been taken only after long and patient study, and each in its turn has been to a greater or less degree the foundation for the succeeding one. In reviewing the various methods, I shall give them in a form as condensed as possible, assuming that the ordinary technique in staining bacteria is somewhat familiar. It is but just, however, to note that each author to be referred to gives a very full account of his experiments, and, in nearly every case, the experiments and results which led to the formulation of the method finally recommended. Although of much interest in the history of the development of the latest methods, the unsatisfactory processes will, as a rule, be omitted at this time.

KOCH'S METHOD.—Koch (4) employed as his staining fluid a concentrated aqueous solution of the extract of logwood.

The bacteria and their flagella were stained by applying this staining fluid in two different ways: *First.* By adding the solution to a small quantity of the germ-containing liquid; *second,* by making cover-glass preparations, by the ordinary method, from the germ-containing substance, allowing them to dry in the air, after which the film on the cover glass was covered with the staining solution and allowed to remain for a considerable length of time. The cover was then rinsed in water and the preparation mounted in glycerine. The flagella were stained a beautiful brown. In order to retain the flagella in a stained condition the preparations were treated, prior to mounting, with a weak solution of chromic acid or with Mueller's fluid. The stained cover glass could be allowed to dry and mounted in balsam. By this process Koch preserved a specimen of the *bacillus tremulus* which showed both the spores and flagella.

NEUHAUSS' METHOD (5).—This method was devised with special reference to the staining of the flagella of the *comma bacillus*. It is as follows:

The dried cover-glass preparations of a culture of this germ were boiled five minutes in common (Kaiser) black ink, after which they were placed in a weak, warmed solution of chromate of sodium for fifteen minutes. This process was repeated two or three times. Upon examination very delicate lines could be seen extending from the ends of some of the bacilli, but they were so indistinct that the author could not positively affirm that they were flagella. It was this failure to satisfactorily stain the flagella of these germs that led Neuhauss to employ photography as a means of demonstrating their presence, as previously noticed.

LOEFFLER'S METHOD. I.—Prof. Loeffler (6) was the first to apply the principle of a mordant in the staining of the flagella and cilia of micro-organisms. He succeeded in staining the flagella on a large number of motile bacteria by subjecting the preparations to the action of a mordant before they were brought into the staining fluid. The procedure recommended is essentially as follows :

The Mordant.—To 10 cc. of a 20-per-cent. solution of tannin a sufficient quantity of an aqueous solution of the sulphate of iron is added to give to the fluid a dark violet color. To this is added 3 to 4 cc. of a logwood decoction (1 part wood, 8 parts water). The liquid will now have a blackish violet color. Care must be taken not to add an excess of the logwood as it would interfere with the staining process. When prepared the mordant should be kept in a well-stoppered bottle, and in order to preserve it, 4 to 5 cc. of a 5-per-cent. solution of carbolic acid may be added.

The Staining Fluid.—To 100 cc. of a saturated watery solution of aniline oil is added 1 cc. of a 1-per-cent. solution of sodium hydrate to give to it a slightly alkaline reaction. This alkaline aniline water is poured into a flask, in which has been placed 4 to 5 grams of powered methylene blue, methyl violet or fuchsin. The flask is vigorously shaken and closed with a tightly fitting rubber cork. This solution can be kept for a considerable length of time. It must always be filtered before using.

The material to be examined must form a very thin layer upon the cover glass. If the germ-containing substance is albuminous, a very small quantity of it is added to a drop of sterile distilled water on a cover glass and thoroughly mixed with it ; a small quantity of this is conveyed to a second cover glass and treated in a like manner ; and again from the second a third preparation is made. By this treatment the albuminous substance is sufficiently diluted, and the microbes are isolated in a watery medium. The preparations are allowed to dry in the air, after which the films are fixed by passing the covers, film upward, through a flame in the usual manner.

A few drops of the mordant are poured over the film and the cover glass held over a flame until the fluid begins to evaporate. It is then removed from the action of the flame, and after a very short time the mordant is washed off in a stream of distilled water. Care should be taken to remove all traces of the mordant from the edges of the cover glass, as it would form, if present, a very troublesome precipitate with the staining fluid. The next step is to filter a few drops of the staining fluid upon the film. This is allowed to act for a brief time, when the cover glass is held over a flame and gently heated. Better results are obtained if the staining fluid is only slightly warmed and allowed to act for a longer period. As soon as the film becomes darkened (a blackish red if fuchsin is used) the stain is washed of in distilled water. The preparation is now ready for microscopical examination. This can be made at once in a drop of distilled water, or the preparation allowed to dry and mounted in balsam.

The microbes with their flagella should be deeply stained, resting upon a colorless background if the germs are in a purely watery medium, but if albumen is present they are surrounded by a uniformly feebly stained medium, the intensity of which depends upon the quantity of albumen present. With this process Loeffler succeeded in demonstrating the flagella on a large number of motile bacilli, spirilla, and upon the motile micrococcus recently described by Ali Cohen.

TRENKMANN'S METHOD I.—Soon after the publication of Loeffler's method, D. Trenkmann (8) announced his process of staining flagella, which in principle is similar to Loeffler's, but differs from it in the composition of the mordant and staining fluid used, and in several of the lesser important details in its application. It is as follows:

The cover-glass preparations are prepared in the same manner as Loeffler prepared his. After they have been dried in the air they are placed (without passing them through a flame) in a fluid composed of 1 per cent. tannin and ½ per cent. hydrochloric acid and allowed to remain in it for from 2 to 12 hours. They are then washed in water and transferred to the staining fluid. This consists of a weak solution of dahlia (2 drops of a concentrated alcoholic solution of dahlia to 20 drops of water). Fuchsin, gentian violet, methylene blue, methyl green, Vesuvian, or Victoria blue may be used. The preparations remain in the staining fluid for from 1 to 4 hours, when they are rinsed and examined. The flagella are stained with any of the aniline dyes, but more satisfactory results are obtained with dahlia, fuchsin or methyl violet. The most desirable stain is carbol fuchsin (2 drops of concentrated alcoholic solution of fuchsin to 20 drops of a 1-per-cent. solution of carbolic acid).

In a second process recommended in the same article catechu was employed. An excess of powered catechu was placed in water and allowed to macerate for several days and filtered. The filtrate impregnates the flagella somewhat feebly without the addition of an acid. The cover-glass preparations, prepared as above, are placed in a solution composed of four parts of the filtrate and one part of a 5-per-cent. solution of carbolic acid. They are allowed to remain in this for from 2 to 12 hours, after which they are stained in the same manner as by the first process.

A third process is recommended, which consists in placing the cover-glass preparations in a concentrated solution of logwood for from 2 to 12 hours, after which they are washed and stained in some of the aniline dyes. Fuchsin is especially recommended. The addition of an acid is said to improve the mordant properties of the logwood solution. The acids proposed are hydrochloric (½ per cent.), gallic (½ per cent.), or carbolic (1 to 2 per cent.).

Trenkmann also obtained positive, though less satisfactory, results, by three other methods of procedure. *First.* The preparations are transferred from the solution of the extract of logwood to Boehmer's or Grenacher's hæmatoxylin solution. *Second.* The specimens are first treated in gallic acid and then stained with some of the aniline dyes. *Third.* The preparations are treated first with hæmatoxylin solution and then with aniline dye.

By the use of these methods he was able to demonstrate the tufts of flagella on many spirilla, especially the *spirillum undula* and a water bacillus.

LOEFFLER'S METHOD. II.—About one year after the publication of his first method, Loeffler announced (7) a second process for the straining of flagella which is a marked improvement over the procedure first recommended. In his careful investigation into this subject he succeeding in discovering an important principle by the observance of which it is supposed that the flagella on all motile bacteria can be stained. *This consists in the degree of acidity or alkalinity of the mordant.* In applying this principle he found that those germs which were acid-producing organisms (those that will change an alkaline medium to an acid one during their development), such as the *typhoid bacillus* and others, require an alkaline mordant, and that the alkaline-producing organisms (those that convert an acid into an alkaline medium during their development), such for example as the *comma bacillus,* the spirillum of Finkler-Prior, the bacillus of blue milk and others, require an acid mordant. The degree of acidity or alkalinity of the mordant necessary to secure the staining of the flagella of a specified germ must be determined by actual experiment; when this is accomplished the method does not differ materially from that first proposed. The formulæ for the preparation of the mordant and staining fluid, together with the details in their application, are as follows:

(1) *The Mordant.*—To 10 cc. of a 20-per-cent. aqueous solution of tannin, 5 cc. of a cold saturated solution of the sulphate of iron and 1 cc. of an aqueous or alcoholic solution of fuchsin, methyl violet, or "Wollschwarzlosung" are added. The fuchsin is especially recommended.

The foregoing solution is to be regarded as the standard or stock solution to be used, and one which is successfully employed in staining the flagella of certain micro-organisms; but for others the addition of an acid or alkali is necessary. Thus for the comma bacillus it is necessary to add to the 16 cc. of mordant ½ to 1 drop of a solution of sulphuric acid equivalent to a 1-per-cent. solution of sodium hydrate; for the spirillum rubrum 9 drops of the acid solution are required. For the typhoid bacillus 1 cc. of a 1-per-cent. solution of sodium hydrate must be added to the 16 cc. of mordant. The bacillus subtilis requires 28 to 30 drops and the bacillus of malignant œdema 36 to 37 drops of the sodium solution. By first determining whether the germ in question is an alkali or acid-producing organism the necessary quantity of the acid or alkali solution to be added to the mordant can easily be determined.

(2) *The Staining Fluid.*—The staining fluid here recommended is ordinary neutral aniline water in which fuchsin crystals are dissolved to saturation. As the aniline water is very nearly neutral a saturated solution of fuchsin in it is sufficient. Better results may, possibly, be obtained by adding to this as much of a 1 to 100, or still better, 1 to 1,000 solution of sodium hydrate as it is necessary to bring it almost to a point of precipitation.

Cover-glass preparations should be prepared from a pure culture (agar or gelatine) of the germ to be studied in the manner recommended in the first process to eliminate all albuminous material. Sterilized hydrant water is preferred to distilled water for diluting the culture. It is of the utmost importance that the cover glasses should be free from all grease or other impurities. In order to clean the cover glasses they are boiled in sulphuric acid, washed in distilled water, immersed in ammoniated alcohol, from which they are dried on clean linen. The film on the cover-glass is fixed by heat, but care must be taken not to overheat the preparation. The desired amount of heat can be obtained by holding the cover between the thumb and index finger over the flame, instead of passing it through the flame by means of forceps. By this method overheating is avoided. After heating, the film on the cover-glass is covered with the mordant and held over a flame until steam is given of. It is then removed from the flame and after one-half to one minute the cover is rinsed in water, then in absolute alcohol, and again in water until the mordant is completely removed. The film is then covered with a few drops of the staining fluid, and the preparation again heated until the solution begins to vaporize. It is then removed from the flame, and, after allowing the stain to act for about one minute, the cover is washed in a stream of water. The preparation can be examined immediately in water, or allowed to dry and mounted in balsam.

By this method Prof. Loeffler demonstrated the flagella on a large number of both saprophytic and pathogenic bacteria. On some of these tufts of flagella are observed, while others possess only one flagellum at each extremity. His paper is illustrated by eight photographs of different bacteria studied by him, on each of which the flagella can be plainly seen.

TRENKMANN'S METHOD. II.—Loeffler's second process was soon followed by Trenkmann's modification of his (Trenkmann's) method (9), in which he introduces iodine water to be applied to the preparation immediately after the mordant. This is based upon the same principle as the use of the iodine solution employed in Gram's method of staining bacteria. This method is thought by its author to be superior to the processes previously announced, because it is more simple in its details and more reliable in its results. The method is as follows:

(1) *The Mordant.*—This consists of a 2-per-cent. solution of tannin, to which ½ to ¼ per cent. hydrochloric acid is added.

(2) *Iodine Water.*—This is prepared by adding a small quantity of pure iodine to a few cubic centimetres of distilled water and allowing it to stand, with frequent shaking, for twenty-four hours. The iodine solution used in Gram's method, or a drop of the tincture of iodine in 10 cc. of distilled water, may be used.

(3) *The Staining Fluid.*—This is prepared by adding one drop of a saturated alcoholic solution of gentian violet to 10 cc. of distilled water. To this, 40 cc. of aniline water are added. The solution remains clear. It stains the bacilli and flagella very well, while the background is feebly, if at all, colored.

The cover-glass preparations are prepared with the usual care to avoid grease or dirt upon the glass and to secure the necessary dilution. Potato infusion is used for such germs as will grow in it. Cultures in this medium are to be diluted 5 to 10 times; bouillon cultures 40 to 50 times, and when the cover-glass preparations are made directly from gelatine or agar cultures a dilution of 100 times is necessary. He employs boiled water for making the dilutions. A drop of a 10-per-cent. solution of alcohol is placed on the preparation and the whole allowed to dry in the air. The dried preparations, without being heated, are placed in the mordant, where they are allowed to remain for from 6 to 12 hours or longer. They are then thoroughly rinsed in water, after which they are placed in the iodine water, where they should remain for about one hour. At the end of that time they are again rinsed in water and transferred to the staining solution. This is allowed to act for about one-half hour, when the preparations are rinsed and mounted for examination, either directly in water or allowed to dry and sealed in balsam. With some germs better results are obtained by varying the quantity of hydrochloric acid in the mordant.

DOWDESWELL'S METHOD.—In a comparatively recent publication Mr. Dowdeswell (10) states, after referring to the method employed by Neuhauss to demonstrate the flagella on the *comma* bacillus, that it is not difficult to detect the flagella on the comma forms if appropriate but ordinary means are adopted. The optical apparatus required are simply a normal retina, a good objective with a moderate angle of aperture, and good light. He recommends as a staining fluid an aqueous solution of gentian-violet, although other aniline dyes will answer quite as well, and for mounting purposes the *acetate of potash*. There are no special directions given excepting that the specimens must be mounted in the fluid mentioned, and not in Canada balsam. He also affirms that no difficulty will be experienced in staining the flagella on microbes as small as the *bacterium termo*.

From what has already been said it will be observed that the flagella differ to a greater or less degree on the various bacteria on which they have been demonstrated. Dallinger (3) figures the flagella on the *bacterium termo* as two thread-like appendages, one projecting from each end of the rod-shaped germ. Their length is much greater than the long diameter of the germ, but their thickness one-tenth that of the bacterium. He gives the mean average diameter of the flagellum of this germ as $\frac{1}{204700}$ inch, which he determined from fifty measurements with each of four different lenses. The flagella on the *spirillum volutans* and several other forms are similarly figured by the earlier investigators. From the plates and descriptions given by Loeffler and Trenkmann it seems that the spirilla and a few bacilli possess one or more thread-like filaments projecting only from the extremities of the organism, but that the greater number of the motile bacteria on which these appendages have been demonstrated are provided with a greater or less number of long, delicate, thread-like filaments. They appear to be given off either single or in tufts both at the extremities and at short and varying intervals along the entire length of the rod-shaped organism. In the stained preparation the flagella appear either straight, curved or in the form of spirals. Many of them are usually detached from the germs, presumably during the process of preparation, and appear as extremely long, delicate bacilli or spirilla lying between the bacteria. This fact renders it difficult to determine with any degree of accuracy the number of flagella belonging to any particular germ.

The question may naturally arise, which one of the different methods presented is best adapted for staining the flagella on any particular motile germ that may be under consideration? In answer to such a question I would say that Dr. Theobald Smith successfully employed Loeffler's second method in staining the flagella on both the typhoid bacillus and the bacillus of hog cholera.

I have also found it to give the best results in staining the flagella on a considerable number of motile bacteria. Although the bacillus of hog cholera is an alkali-producing organism, Dr. Smith stained its flagella by using the neutral or standard mordant (11). I have found, however, that the flagella on this bacillus stains quite as well by adding from one to three drops of the acid solution to the mordant, which shows that the range in the reaction of the mordant that can be used in staining the flagella, on this germ at least, is much greater than might be inferred from the method. This is of considerable importance, as it will, if true with respect to all germs, greatly diminish the number of test experiments in order to determine the degree of the reaction of the mordant necessary to be used with the germ in question. With Trenkmann's second process I have been partially successful, but with the other methods I have met with only negative results. Thus far, however, my experience has been too limited to undervalue these methods, or to recommend too highly the one with which I have been, in a measure, successful.—*Microscopical Journal.*

THE EXAMINATION OF THE BLOOD FOR LAVERAN'S MALARIAL GERM.

The following, from *The Canadian Practitioner* of May 16, 1891, will prove of interest to many physicians:

Laveran's directions for examining the blood of malarious patients are as follows: The blood should be taken at the height of a fever attack, and from a patient who has had no quinine for some time. The blood should be taken from a finger tip, after a thorough cleansing of the skin to be pierced. The cleansing should be such as to prevent all chance of contamination of the blood as it oozes out. The drop so obtained is to be taken upon a clean cover glass, and a second cover placed upon it, so that a thin layer of blood may be obtained between two cover glasses. This fresh preparation is then to be examined by daylight and with a dry lens of high power. In this way one will oftenest be able to see the flagella on the periphery of the round, pigmented, free corpuscles. If a dry preparation be desired, then the cover glasses must be separated from one another and the blood dried by passing the cover glass three times through a flame. The specimen can then be examined either stained or unstained. Laveran stains with a concentrated watery solution of methyl blue, before using which he washes the cover in a mixture of equal parts of alcohol and ether. By this method the nuclei of the white blood corpuscles are stained dark blue, the free, round bodies, or those attached to the red blood corpuscles, a pale blue, while the still growing corpuscles stain hardly at all. For specimens so prepared, Laveran recommends dry lenses also.

MISCELLANEOUS.

THE REALM OF THE MICROBE.

MRS. PRIESTLY.

Nineteenth Century, London, May.

All living things throughout the animal and vegetable kingdoms are composed of cells, springing, in the first instance, from one single cell. The entire human child, with all its great future possibilities, is, as Hæckle says, in its first stage only a single ball of *protoplasm monerula.* But at the other end of the scale we have microscopic organisms, existing as simple cells, capable of performing all the functions of life, and of playing an important role in the economy of nature.

Pasteur, in the course of his study of the germ theory, argued that all that has lived must die, and all that is dead must be disintegrated, dissolved or gasified; the elements which are the substratum of life must enter into new cycles of life. One grand phenomenon he saw, presides over this work —the phenomenon of fermentation.

What, then, is the cause of fermentation? In order to answer this profound question, Pasteur devoted himself to the study of the microscopic beings, which he finally divided into two great classes, the aerobies and the anaerobies, those which require free oxygen for their existence, and those which are killed by the presence of free oxygen, although able to wrest oxygen from the materials whence they derive their nourishment.

The aerobies are those which begin work on the surface of things, their mission being to clear the earth, by a process of slow combustion of all that is dead. The anaerobies, working simultaneously, spring into activity underneath the surface of putrescible matter, and, dying on exposure to the free oxygen of the air, are, in their turn, swept away by the aerobies on the surface.

Thus the two great classes of minute living organisms co-operate towards the fulfilment of a common end, the one beginning work which the other takes up and completes. But for their united efforts we should cease to live, for the earth would be littered with fallen debris and the organic matter of every kind, all of which it is their function to transmute into the very elements which are necessary to life again. In the parts of the earth where these organisms do not exist there is no vegetation, no organic matter, no life of any kind ; the region is one vast field of ice, a sandy desert, or an expanse of eternal snow. When perchance these desolate places are invaded by living creatures who starve and fall by the way, there is no decay, for the organisms whose office is that of putrefaction are not present to perform their analytical functions. "Thus," says Pasteur.

> "The destruction of everything that has lived reduces itself to the simultaneous action of these three great natural phenomena, fermentation, putrefaction and slow combustion. The carbon, the hydrogen, the nitrogen of organic matters are transformed by the oxygen of the air, and by the action of these aerobies, into carbonic acid, vapor of water, and ammonia gas."

Having thus recognized the vast importance of these minute organisms, Pasteur, the chemist, watched, with unceasing interest, the work of these greater chemists in Nature's own laboratory. Not only were they engaged in the immense business of preserving the balance between life and death, but they participated largely in the everyday work of the world, and were taking an active part in the industries of man. The power of these lowly and invisible creatures is so enormous that they are well called "the masters of the world." If we neglect the laws of health they are the Nemesis which deals punishment ; for in the steady, ceaseless pursuit of duties, they spare none. All organic matter is the same to them whether it be the human body living or the dungheap at the cottage door.

In nature, some of these organisms live only in living bodies, and are consequently distinguished as parasites, while others live on dead bodies, and are known technically as saprophytes, but in the laboratory both forms as a rule can be cultivated on artificial material, rabies being an exception, as it can only be cultivated in the living bodies of animals. The Rev.

Dr. Dallinger, who keeps a museum of living putrefactive organisms, describes one of them, to which he has devoted special attention, and thus reveals the marvelous workings of nature in a world we cannot see. This creature is so minute that the average measurement is $\frac{1}{10000}$ of an inch in length and $\frac{1}{19500}$ of an inch in breadth. Nevertheless, it has six flagella, each one of which is three times as long as the length of its body. The movement of these creatures is exceedingly beautiful and graceful, with the long flagella waving to and fro. After a moment's rest the group under observation will be seen to start into active movements in a series of wavelike leaps, reminding one of the movements of a shoal of porpoises, which is continued for from ten to fifteen undulations. This organism, unlike others described by Dr. Dallinger, was never anchored and had no power of attaching itself, but by freely darting upon the matter attacked, such matter was visibly, in the course of half an hour, reduced in size and altered in shape. Each one in turn, in a space of about two seconds, comes into contact with the particle and at once recedes to a distance of four or five times the length of the flagella, and instantly again darts upon the object, and this may be continued by given forms for hours.

Fifty to a hundred may be seen with ease in one microscopic field pursuing their untiring work. It is the more entrancing that it is apparently rhythmical, not like the measured march of a regiment, but the rhythmic movement of a peal of bells.

These are examples of the putrefactive organisms at work throughout nature, in company with a vast number of other forms, all engaged in ridding the world of putrescible matter.

It is difficult to imagine any study more fruitful in happy results to mankind or more intensely fascinating to the student, than that comprised in the new world of the invisible.

The point where perhaps most discussion has taken place is that on the border line between the pathogenic and the nonpathogenic organisms. In some cases, for instance, that of the *bacillus subtilis* and the *bacillus anthracis* the difference is so slight that it can hardly be detected under the microscope, yet the one is harmless to man, and the other deadly.

From the study of the familiar fermentation of yeast, Pasteur passed to the study of the diseases of beer and wine, and thence to the silk-worm disease, which latter proved the connecting link which established the general relationship between the diseases of beer, wine, and all putrescible things, with the diseases of all living creatures from silk-worms to man.—*The Literary Digest.*

THE MEDICO-LEGAL VALUE OF THE GONOCOCCUS.—Since the discovery of the gonococcus, and since its general acceptance by the medical profession as a means of differentiation between specific and non-specific blennorrhœa, hopes have been entertained that it might prove of value in medico-legal cases, especially in those instances of vulvo-vaginitis occurring in children, and often giving rise to suspicions of criminal practice. Neisser, Lober and Kratter all assert very positively that, by the aid of the microscope, they can determine without question whether the vaginal discharge is gonorrhœal, dependent upon impure contact, or whether it is non-specific, in which case it may be evoked by any one of a large number of irritants.

Vibert and Bordas (*La Medicine Moderne,* November 13, 1890) point out that to be of value in legal medicine the proof must be absolute, and that probabilities are of little avail. The vagina contains, even in health, a vast number of micro-organisms. If the secretion of an acute vaginitis occurring in the person of a little girl is examined, diplococci, presenting all the characteristics of the gonococcus, are usually observed.

In those cases examined by the authors, the cause of inflammation was purely traumatic, and, according to the evidence, it was scarcely possible that gonorrhœal pus had come into contact with the mucous membranes. The discharge of these cases contained diplococci resembling in every respect gonococci. From four cases pure cultures of this micro-organism were obtained, in the remainder there were other varieties. The diplococci were found always in the interior of the pus-corpuscles, and were very abundant. In form, in dimensions, in position, in grouping, in habitat, and in reaction to staining fluids, these micro-organisms were identical with gonococci.

It is well known that in the Gram method, the aniline stain affects all micro-organisms likely to be found in blennorrhœal pus, excepting the gonococci ; hence, when a preparation previously colored is washed for some minutes in Gram's solution, and is then dehydrated in alcohol, the gonococci are completely decolorized. The diplococci of non-gonorrhœal pus act in the same manner.

Other authors, and especially Bumm, have asserted that there are micro-organisms which cannot be distinguished either morphologically or by staining methods from the gonococcus.

It would seem, from the present evidence, that the results of microscopical examination of vulvo-vaginal discharges are not sufficiently conclusive to warrant a positive statement either for or against impure contact.—*Philadelphia Medical News.*

RESORCIN IN SEPTIC POISONING.—Andeer (*Chem. Centralblatt*), in view of the many deaths which have recently occurred from dissection wounds, poisoning by cadaverous alkaloids, etc., calls attention to the uniform efficacy of resorcin as a remedy in such cases. On the other hand, in antidoting the venom of serpents and insects, it is only occasionally successful—a fact which the author explains by supposing that resorcin acts antiseptically upon morbid matters which are alkaline or neutral in reaction, but is powerless or hurtful when they are acid.—*Druggists' Circular.*

FISH POISON.—The *Vierteljahrsschrift fur Gerichtliche Medicin* calls attention to a very important matter in connection with the use of fish as a food. It appears that an investigation of the result of eating fish, preserved on ice for use in the London markets, has led to the discovery that those were most dangerous which were kept in immediate contact with the ice. Poisoning by fish which had not been in contact with ice was not observed at all. This is attributed to the influence of the water derived from the ice, and bearing whatever impurities it has had before being frozen, which promotes the formation of the animal alkaloids known as fish poison.—*Druggists' Circular.*

PREVENTION OF DIPHTHERIA.—Dr. Augustus Caille concludes a paper on this subject, read before the American Pediatric Society, by saying that at the present time his conviction is firm that, in the absence of filthy carious teeth and nasal obstruction from adenoid vegetations or greatly enlarged tonsils, the daily prolonged use of mild antiseptic liquids by means of spray, insufflation or gargling, will prevent diphtheritic infection. He claims, also, that this procedure is indicated for those who are exposed to diphtheritic infection; and, also, as routine treatment for every case of nasal catarrh, pertussis, measles and scarlet fever, in fact, for every condition in children in whom the naso-pharyngeal mucous membrane is hyperemic or congested, and therefore predisposed to diphtheritic infection.—*Druggists' Circular*.

SALT IN MILK FOR CHILDREN.—The addition of sodium chloride prevents the solid coagulation of milk by either rennet or gastric juice. The cow's milk ought never to be given without table salt, and the latter ought to be added to a woman's milk when it behaves like cow's milk, in regard to solid curdling and consequent indigestibility. Habitual constipation of children is influenced beneficially, since not only is the food made more digestible, but the alimentary secretions, both serous and glanular, are made more effective by its presence.—*Arch. of Ped.*

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EDITORIAL.

THE ROLE OF MICROBES IN THE DIGESTION OF FOOD.

It was Pasteur who first ventured the opinion that possibly microbes were useful factors in normal digestion in the animal world. Duclaux, in his celebrated biological chemistry, impressed one as believing, to a limited degree, in this theory. We are told, though we confess never having read it, that Vaughan is imbued with the same idea also, in a limited sense.

Judging from natural laws governing nourishment immediately after birth in large animals, one would think that this must be a somewhat unreasonable theory. Indeed, it cannot be shown that, in case of a child excluded from bacteria from the moment of its birth, life would cease, because digestion must fail in the absence of digestive ferments in the alimentary tract.

In fact, the digestion of the first milk in the young, taken from the breast, is free from microbes and goes into a canal likewise unpolluted; and there is no good reason to believe that if these conditions were kept up until the adult stage the subject must starve. An organism has naturally the powers and activities necessary for digestion and other functions, irrespective of the aid of other foreign living organisms as a necessary adjunct.

True, there are to be found in the mouth and alimentary tract bacteria capable of causing certain changes comparable to the natural digestion. For instance, starch may be converted into sugar in the mouth; it is possible even that ptyalin is not so active in that sense as was believed, and that microbes increase this converting power. But this does not prove their necessity in the mouth, for the animal is capable of operating this transformation in the small intestines by the action of certain principles in the pancreatic juice.

It is a fact that microbes produce, for the purpose of their own nourishment, digestion of food similar to digestion by complex beings, but it is for the sustenance of their own structure and not directly of other beings. Their action in this line in the alimentary canal is purely accidental, in the sense that it is not a necessary phenomenon of the growth and life of beings thus harboring them.

But what *role* do these microscopic organisms — minute ferment germs — play in cases of indigestion? Here they are, indeed, a great factor, and, if they may be *valuable in accidentally assisting* in the dissolution of *too much food ingested*, or a quantity of foodstuff that the animal organism *cannot fully* overcome, they may also cause, during the process of transformation, very serious disturbances.

The stomach of a human being for instance, like the heart and other organs, has a limited capacity beyond which it cannot safely be taxed. There is a reserve force for a case of emergency, say, to digest the pound or more of surplus albumenoids and other stuff ingested by the *bon vivant* or glutton at a four-hour-long banquet, just as the heart may beat one hundred and eighty and more a minute in the efforts to carry oxygen to the tissues in case of disease, fever, but this is an unnatural activity which, if continued, must sooner or later result in incapacitating the stomach; it eventually becomes exhausted and fails to secrete the necessary digestive fluids in sufficient quantity and proper quality. The same thing may be said of all the other overtaxed digestive organs. If they are kept under constant strain, secreting, churning to their utmost capacity, they must soon fail, as the street-car mule, pulling to its utmost, drawing daily on its reserve force under the driver's whip, is bound to fail. Exhaustion, more or less complete, is inevitable. What then follows?

The gastric juice, being deficient, has lost partly its germicidal properties as well as digestive properties. The food swallowed fails of complete digestion; that which is digested is acted upon simultaneously by the natural ferments of the body and by the ferment (or decomposition or transformation) microbes; the surplus that fails entirely of natural digestion is decomposed largely, if not entirely, by microbes.

What is the result of such complicated and unnatural transformations? The result is practically as we would find them had we followed the process in a tin dish. The sum total *is putrefaction* in part at least with the usual results. It is not a natural process of digestion, but a "rotting process," if you will pardon the expression, which though it does aid in freeing the body from its inconvenient load does so in a very dangerous and often a very painful way, thereby complicating the functional troubles brought about by unwise feeding, and doubtless often producing some organic lesions that eventually end in death. Consider the results of the decomposition of foods serving as man's nourishment for instance, and see what products may be the result of chronic or acute indigestion under the converting influence of bacteria. In the phenomena which follow, "sugar is transformed into lactic acid, mannite, dextrine, glycerine, butyric acid, mucilage, etc Alcohol is transformed into acetic acid, urea into carbonate of ammonia, etc. There is generated the putrid poisonous substance named sepsin; the septic alkaloids of Zulzer and Sonnenschein; the ptomaines found by Selim, Gautheir, Breiger, Vaughan*; certain narcotics, leucine and tyrosine, butyric, palmitic, margaric and fatty acids; volatile products, iodol, phenol, scatol, sulphurated hydrogen, ammonia, carbonic acid, water," etc.

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* Name added to quotation by editor.

With such a quantity of chemical products (many of which are pernicious) produced in our bodies, is it a wonder that the head aches, and the whole anatomy of the dyspeptic is sore, and he sometimes ends in the insane asylum? Is it not rational to conclude that when one converts one's stomach into a laboratory for generation of products of decomposition, putrefaction, they produce disease by their direct local action, their action on the nervous centers, their action on the blood and every cell of every organ of the body when absorbed and carried to them with the food intended to nourish them? Verily, indigestion is a method of poisoning by nature's processes. Indeed, when produced by gourmandizing, intemperance, knowing both to be injurious, it is a species of slow suicide; leaving aside the cause and intent, it differs from the arsenic poisoning mainly in the degree of rapidity in accomplishing the end.

LESSONS IN BACTERIOLOGY.

LESSON SIXTH (*Continued*).

BY PAUL PAQUIN, M. D.

CULTURE MEDIA, ETC.

SOLID CULTURES (continued).—All broths which have been gelatinized or to which has been added agar-agar for the purpose of solidifying should be put in test tubes or small culture flasks, vials, and the like, while still warm; for, in cooling, they will lose their fluidity and become a jelly-like mass. If one desires to keep such material in stock it should be placed in a large flask (previously sterilized, of course, just as the test tubes, etc.), and then the final sterilization process carried on. When any of the material is needed, put the flask in a water bath, and, as soon as melted, fill the culture recipients as may be desired. Always remember that whenever a stock flask is opened it should be sterilized again at once, for air germs are likely to have entered it and may soon grow.

To make any broth clear, transparent and free from cloudiness it is better to use the albumen of egg in the following manner: For each pint of culture broth beat the white of one egg, in one, two or three ounces of water; let the broth cool a little after the boiling and before *last filtration,* then add the beaten egg. Boil again a very minutes in the water bath and filter. I have mentioned the addition of egg albumen before but did not state the mode of procedure.

To obtain a larger surface in the tubes, allow them to cool in a slanting position after sterilization.

BLOOD SERUM.—This material is sterilized properly only with great difficulty. It is indeed almost impossible to succeed in getting a pure, good transparent serum medium without special apparatus. The reason will be apparent to all. Sterilization is usually effected only by very high heat applied once, or repeated heating at nearly or quite 212° F. In either case blood serum coagulates at such temperatures as the albumen of an egg in boiling water and becomes white, opaque; its surface soon dries and it is unfit for the proper cultivation of bacteria.

The usual way of getting blood serum for culture media is as follows: A glass jar, say a Mason fruit jar, plugged with cotton is wrapped thoroughly in a few thicknesses of dense cotton cloth, linen or paper, and then sterilized at dry heat in the manner indicated for such sterilization. The jar is carried to a slaughterhouse and the wrapping removed only just before filling it. Remove plug of cotton carefully, give it to an aid to hold, with under surface downwards, then with the greatest possible care and cleanliness allow blood from a calf (or older bovine) to enter the jar. When nearly full replace plug of cotton and carry the blood to your work room (laboratory) *without* shaking it if possible. Once there, place the jar in a dish of cold water and put the whole in a cool place (ice box) to allow the clot of solid material to form, and the serum to separate all around it. After about thirty hours the serum may be drawn carefully from around the clot (without disturbing the latter) by means of a glass pipette sterilized or a sterilized rubber syphon and made to run into sterilized culture tubes. All care possible should be taken to transfer the serum from the jar to the culture flasks or tubes, because air germs might enter with serious consequences. owing to the fact that blood sterilization must be effected at a comparatively very low temperature. Do not moisten the lips or the upper portion of the inside walls of the tubes; because, in the heating to follow, they may fail of sterilization if the water bath process is used, and this is the only way available where one has not gone to the expense of fitting up a laboratory with an assortment of more or less expensive instruments. The test tubes (always sterilized) being filled and plugged, place them in a wire basket or perforated tin pail and plunge the whole into a water bath kept at a temperature of about 120° F., which may be maintained thus by close watching by means of a low gas jet or an alcohol lamp. Repeat this heating once a day for about a week when sterilization ought to be complete and the medium sufficiently clear to serve for the cultivation of bacteria. In order to get a larger culture surface of this solid material it is only necessary to incline the tubes with care within the wire basket or pail, if the size of it will admit, and to leave them untouched until the last heating.

Dry-heat sterilization of blood serum is effected by means of a special serum "coagulator and sterilizer," which requires no special technology to manage.

The heating is repeated at dry regulated heat as for the method just described. Certain instruments are on the market to regulate the heat of such apparatus as well as to regulate the heat of culture ovens or incubators to be designated later. They are very handy, but not indispensable.

POTATO CULTURE.—The potato constitutes an excellent nutrient soil for the cultivation of bacteria of various kinds, though it does not afford the growth of all germs. The field of culture is prepared by sterilizing mashed potato on glass plates about six inches by four, in shallow special dishes or round trays covered by another larger but similar vessel serving as lid.

The usual potato cultures, however, consist merely of cooked potatoes cut in two under the most carefully aseptic methods—the two cut surfaces serving as the culture field.

Take neat medium-sized potatoes having no injuries, few eyes, or specks; wash several times in clean water rubbing them with a brush or stiff rough towel and rinsing in clean water (scalding preferred); then immerse them for an hour in a solution of bichloride of mercury 1-1000. Place them in a perforated pail or wire basket and cook them by steam in an ordinary covered kitchen steamer or in a special laboratory steamer. In thirty or forty minutes the steaming will have destroyed the remaining external micro-organisms and cooked the potato sufficiently. Let them cool down without opening the steamer and they are ready to be cut in two and serve as culture material.

Before doing this, however, another step must have been taken in another direction. Whilst the potatoes were cooking, dishes to receive them as culture media should have been prepared. These dishes consist of circular trays in pairs in the form of a stiff straw hat without rim—the larger forming a lid for the smaller, just as if in covering low tumbler (glass) with a larger one fitting loosely over the mouth. These dishes are washed clean, sterilized by shaking a 1-1000 solution of bichloride of mercury in the dishes closed, allowing the solution to run out gradually by tipping over and without removing the cover entirely. The object is to wash these dishes thoroughly with bichloride (after using only water); drain them and yet do the whole in such a way as to expose the inside surfaces as little as possible to the air. In order to keep dampness in the potato chamber thus prepared a (circular) piece of filter (or other) paper is saturated with the bichloride solution and placed at the bottom. It is safer, however, to put this paper in in washing; put a good deal of the liquid in and allow it to come in contact with every portion of the dishes inside without exposing them any further to the air. Then dip the hands in the same kind of solution (kept in another dish for the purpose); sterilize the blade of a sharp enough kitchen knife by passing it in the blaze of a gas burner or of an alcohol lamp three or four times; pick a potato from within the steamer with the index finger and thumb of the left hand, the lid having been removed most carefully by the right hand, holding also the knife with edge of blade upward, or better by an assistant; sever the potato in two and carefully place in the dishes or circular glass trays.

The cut surfaces, at this stage, are still in contact sticking together; by carefully lifting the lid to one side to introduce the knife blade they can be separated with the (freshly sterilized) point forced into the incision, thus turning upward the cut surfaces of each half of the potato.

Leave the potatoes thus prepared two or three days at a warm temperature before inoculating them with any bacteria; the object is to allow the growth of any air germ that may have accidentally fallen on the potato during the various operations. If any growth should develop from air germs the media is useless for any inoculation or special growth.

During all this work one thing must be kept constantly in mind, *i. e.*, the object sought is two clean cut surfaces, perfectly sterilized in the center of a sterile potato, inclosed in sterile dishes. A little practice will soon render one perfectly competent to accomplish this easily. It is unwise to try and cultivate special bacteria on a potato surface, or any other culture media, before giving sufficient time to the material to develop any growth of germs fallen accidentally therein or thereon.

(Seventh lesson in August number.)

ORIGINAL ARTICLES.

TRANSFORMATION AND ELIMINATION OF THE ORGANIC MATTER BY THE PYOCYANIC BACILLUS.

BY MESSRS. A. ARNAUD AND A. CHARRIN.

Before the Academy of Sciences, Paris, France.

In a preceding note, we have made known the transformations resulting in the organic matter (asparagine) under the vital influence of the pyocyanic bacillus. We have studied the mode of elimination of nitrogen; it remains, among other things, to establish the carbone of the carbon of this asparagine.

The weight of the carbon of the liquid of culture is, at the start, 1 gr. 600 per litre, quantity corresponding to the 5 grams of the asparagine employed. The direct dosing of $C O^2$ disengaged, during the fifteen days of the evolution of the microbe, has given some figures coming close, in average, to those that it is possible to calculate, in holding account of the carbon fixed in the microbian protoplasma, and of that which enters in the composition of the substances of secretions, substances not yet determined, constituting the fixed residue. The results of the analyses are as follows:

RESPECTIVE QUANTITIES OF SUBSTANCES ELABORATED AT THE COST OF THE ORGANIC MATTER (ELIMINATION OF THE CARBON).

Total carbon in 1 litre of culture	*1 gr., 600.
Carbon released in the state of carbonic acid.	1 gr., 160 or 72.5 per 100.
Carbon combined in the microbic protoplasma	0.221 mgr. or 13.8 per 100.

Carbon of the soluble substances, fixed products of secretions not determined(1).0.216 mgr. or 13.5 per 100.
Carbon in combination secondary products, pyocyanine, methylamine and loss in the analysis..................... ....0.003 mgr.

*Gr. stands for grams not grains.

The determination of the oxygen fixed by the bacillus presents interest. Our experiments have not, until now, given absolutely concordant results. In order to arrive at exact results, we have undertaken some analyses by different methods. Still the analysis, in accord with the calculation, shows that this quantity of absorbed oxygen is in relation to the proportion of CO^2 which has been created ; it can be estimated, at from one and a half to two times the volume of the culture.

In the void the evolution is poor ; CO^2 permits no development. In hydrogen we note fairly great activity ; ammonia is formed, we have not yet studied by which mechanism.

We have completed our researches in making the medium vary. Instead of utilizing the asparagine, we have taken the gelatine, more complex in constitution, taking care to add the necessary nutritive salts. The curve of elimination of the nitrogen matter is then more regular than the asparagine ; it seems that the diastase of the bacillus does not intervene and that this bacillus assimilates directly the elements of the gelatine. The results are resumed in the following table :

	Grams.
Total nitrogen at the start of the culture, March 30, 1891	0,757
Nitrogen eliminated in the state of ammonia, 90 hours after the start	0.1344
April 7, 196 hours after the start	0.3444
April 9, 234 hours after the start	0.4564
April 14, 360 hours after the start	0.5124
April 16, 420 hours after the start	0.5272
April 21, 528 hours after the start	0.530

From this moment (twenty-second day) the ammonia augments no more. In a similar medium the nitrogen eliminated in the state of ammonia is then from 70 per 100 of the total of the nitrogen, instead of 91 per 100 in the culture of the asparagine. On the other hand we observe that the weight of the microbes is very considerable; it is of. 0.990 per litre (0.420 in the asparagine culture); the weight of the organic soluble matter fixed attains 0.495 (0.330 in the culture of asparagine). We may conclude that in order to study these last principles of secretion, so interesting from a physiological point of view, it would be preferable to employ the medium of gelatine. In this case the formation of pyocyanine is almost wanting.

Notwithstanding the absence of this pigment, the special products, as experiments demonstrate, are active. On the indications of Mr. Bouchard we have sought their actions. Not being able at the moment to study them separately, we have had recourse to the following method followed by this author, to measure the toxic properties of the urines. By physical means of dissociation, these products have been separated into three groups — the volatile, the insoluble in alcohol, and the soluble in alcohol, *i. e.*, three extracts.

A very clear property characterizes the first one, that is, the portion separated by distillation. This extract acts on the vaso-motors, paralyzes the dilator centers, contracts the vessels slightly.

Introduced in the organism of the rabbit, the matters of the second extract, taken again by the water or the glycerine, cause diarrhœa, fever, albuminuria, hemorrhages; they weaken the resistance of the vaccinated, are opposed to diapedesis, alter the tissues. The heat diminishes their poisonousness. In the lowest dose the toxic power is not appreciable, while the vaccinating power is noticed. This second extract contains some most important secretions; it is poisonous and produces vaccination by temperature; we can, nevertheless, diminish its deleterious effects in preserving those which are useful. There is not absolute parallelism between these two properties.

As to the third extract, it causes convulsions, and, if the animal does not succumb immediately, generally the subject recovers in the end: while, if. without going to a mortal dose, insoluble principles have been used, he becomes sicker and sicker.

This third extract sometimes raises the temperature, but it never renders refractory any more than the first. So that there are some microbic substances which are morbific and not vaccinal.

We must add that the ordinary principles of the life of bacteria, such as the ammonia, becoming too abundant, may enter in line of reckoning of the power of poisoning.

The diverse propositions advanced are all justified by numerous experiments.

HYGIENIC BACTERIOLOGY.

CORROSIVE SUBLIMATE AS A DISINFECTANT AGAINST THE STAPHYLOCOCCUS PYOGENES AUREUS.

BY B. MEADE BOLTON, M. D.

A. C. Abbott (Johns Hopkins *Hospital Bulletin,* No. 12, April, 1891) publishes the results of the test made upon cultures of the staphylococcus pyogenes aureus with a 1-1000 solution of corrosive sublimate. Abbott finds that the disinfectant power of corrosive sublimate in the above concentration, when tested by methods which exclude the carrying over of minute quantities of the disinfectant, is not so great as has been claimed. He holds that, in many of the experiments heretofore made to test corrosive sublimate, the latter has been assigned a higher rank than it deserves, because some of it has been transferred to the culture medium, and has inhibited, but not destroyed, the growth.

His experiments were made upon liquid cultures containing sterilized sand. With cultures of this sort he was able, by filtration, to get a better distribution of the organisms in the liquid, avoiding macroscopic clumps, which might interfere with the action of the disinfectant upon the organisms in the center. Suspensions in water were also used—also filtered. Fresh cultures and fresh solutions of corrosive sublimate were used, of course, in every case.

Abbott finds that the number of organisms makes a difference in the efficacy of the disinfectant. The greater the number of organisms the more difficult the disinfection. Cultures vary in their resisting power—organisms from one culture resisting better than those from another. Cultures in beef-tea resist better than suspensions in water. Organisms which remain alive after the action of the disinfectant are retarded in their growth and are weakened in virulence. Corrosive sublimate in the proportion of 1–400,000, retarded growth in cultures of bouillon containing peptone, 1–600,000 without peptone. The staphylococci, which have been attenuated by the action of the sublimate, regain their virulence when cultivated for some time on ordinary culture media.—*Brooklyn Medical Journal.*

INFLUENZA BACTERIA.

A recent number of the *Progres Medical* contains an abstract of an article by Professor Babes, which appeared in the *Centralblatt fur Bakteriologie und Parasitenkunde* on the subject of bacteria in influenza. The author has succeeded in isolating two varieties of micro-organisms to which he thinks that in all probability the pathological element in the causation of influenza may be attributed. Those of the first variety form short chains, are immobile, and are not stained by Gram's method. Their colonies are small in dimensions, transparent, and developed through the entire culture media. They have been proved capable of producing active pulmonary inflammations. The bacteria of the second class produce on agar-agar colonies that present a dark center and a whitish periphery. They are also immobile, but, unlike the first variety, are colored by Gram's method. In mice, the inoculation of this culture produced fatal pneumonia, the bacilli being found in the blood-vessels ; and in rabbits a local inflammation resulted.—*New York Medical Journal.*

THE FORM OF DYSENTERY PRODUCED BY THE AMŒBA COLI.

BY W. T. COUNCILMAN, M. D.

Dysentery, as a word, was first used in a clinical sense. It meant tenesmus. It is an inflammation of the large intestine. The pathological lesions are exceedingly numerous and varied. It would be absurd to suppose that all forms of dysentery come from the same cause, just as in pneumonia. The pulse is rapid. The case may last several months. In the anatomical lesions which are produced there is much variation. Some die before ulceration begins, and other cases are not so virulent. The lesions are in the submucous tissue. Clinically the disease is chronic. It begins with a diarrhœa. It is intermittent in character, may last for a month, stop, and then break out again. There is no pain in the earlier stages, but later there is pain; the diarrhœa becomes worse, and there is tenesmus. The stools are mixed with blood. There is usually no fever in the entire course of the disease, emaciation still goes on. The duration may be from three to six months. Towards the last the complexion assumes a dull, earthy-like color. There is nothing distinctive in the stools; they are always fluid, and considerable in amount. When these patients die, the anatomical lesions are exceedingly characteristic. There is entire absence of diphtheritic exudation, which one finds in the acute cases, and the surface of the bowel shows numerous ulcerations. These ulcers are relatively small, and the surface is mammilated. There is a small loss of substance at the apex of these elevations, and an abscess cavity; and on this a depression is filled with an opaque, greyish, gelatinous-looking mass. The entire intestine is much thickened, the muscular coat thickened Then large ulcers can be found which run into each other, so that we may have long, sinuous passages running through the intestines in various directions, and the membrance becomes undermined, sloughs and falls off. It extends to the mucosa and the muscular coat, and large sloughs are cast off. The microscopic characteristic appearance is evident. The amount of sloughing is often extreme, some as large as the hand.

This is interesting from the complications. The most frequent is the abscess of the liver. There has been seen at the Johns Hopkins Hospital eleven cases of this form, of which five died and three are still under treatment. Of these eleven cases, four deaths occurred from liver abscess, and one case of liver abscess is still under treatment. The abscesses of the liver are fully as characteristic as in the intestinal ulceration. The liver abscesses are filled with a gelatinous-looking mass. If they are larger they may have a distinct fibrous form, and look like other forms of abscess.

The next most common complication is abscess of the lung. The formation of abscess of the lung is interesting. In four cases at the hospital, three had abscesses of the lung. The lung abscess comes from the liver abscess. The liver abscess is on the upper surface of the liver. There is an adhesive pleuritis and the lung abscess follows. It is very insidious in its outset, there is always pyrexia, abdominal pain and much sweating. When the lung complication takes place, the appearance of the sputum is characteristic—tough, of dingy cherry-red color, as in acute pneumonia, so that the spit-cup can be turned up without the sputum running out. The sputum also contains small masses of necrotic tissue, lung tissue. The cause of the disease has long been suspected. Davaine, in 1853, described the cercomonas in the stools. Then Lander, in Prague, found small amœbæ in the stools of a child which had died of dysentery, also in cholera. Cholera patients in India by Cunningham and Lewis. Lerch, of St. Petersburg, was the first to describe this as we now know it. It is an amœba $\frac{1}{1000}$ to $\frac{1}{400}$ of an inch in length. It is either round or is undergoing movements. The outer part is a homogeneous mass, and the inner part is filled with granular matter. The movements are active, and its large size makes it easy to study under a low-power microscope. It may be seen to change its form and shape under the microscope. It puts out its pseudopodia and draws them in again. It is found in the stools, in the abscess of the liver and lung. We find in it things which the organism has taken up for food, as for example, red blood corpuscles. The organism may be seen in the microphotographs, which are passed around. He thought this form of disease was not so uncommon as many thought. He had tried to find the geographical range of the disease. Woodward also had written largely on dysentery, had recorded six hundred and ninety-three deaths from intestinal affection. —*Journal of the American Medical Association.*

MEDICAL BACTERIOLOGY.

THE TREATMENT OF MALARIA.

Laveran finds that in the contest between the organism and the hematozoons, the leucocytes play an important *role.* It is a well-recognized fact that, if an insoluble and finely-pulverized substance be injected into the blood of an animal, the leucocytes rapidly invade this powder and charge themselves with its elimination from the blood (Ponfick, Hoffman, Langerhaus) .

The researches of Metschnikoff prove that the leucocytes not only invade inert powders and the bodies of microbes, but also, in a great number of cases, the living pathogenic microbes, and that this property, known as *phagocytosis,* plays a very important *role* in the evolution of infectious diseases and in the phenomenon of immunity. The cells of the splenic pulp and those of the endothelium of the connective tissue, and of the pulmonary epithelium participate in this power. He has also concluded that the paroxysm of the fever persists during the life of these microbes in the blood, ceasing only when the parasites become the prey of the phagocytes. Especially is this marked in relapsing and malarial fever. The resistance which the microbes exert against this action of the leucocytes may be of long duration if they be lodged in the spleen or in the marrow of bone.

Wyssokowitsch has noticed that the spores of the *bacillus subtilis* lodged in the spleen were still living at the end of three months, an interesting fact in a point of view of the study of latent microbism.

Metschnikoff, Golgi Gamaleia and others insist upon the destructive action of heat upon the microbes, while, on the contrary, cold diminishes the activity of the phagocytes. It is well known that an organism placed in the best general condition will resist most successfully the inroads of the pathogenic microbes, whilst all debilitating causes militate against the cure of malaria. Laveran himself has observed in animals whose blood contained hæmatozoa, that under the influence of an abundant alimentation the microbes disappeared, while dilatation favored their development. The anæmic diseases—over-fatigue, ill nourishment—are attended with frequent relapses of the fever, and the salts of quinine themselves seem to become powerless in preventing these relapses. On the contrary, under the influence of only a good regimen and rest, frequently the condition of malarial patients will ameliorate, the anæmia grow less, the relapses less frequent, and a cure may occur without the intervention of a more active medication, simply because the organism has been placed in the best hygienic condition.

All the tonics have, consequently, a favorable action upon the progress of the disease, and foremost among these may be placed wine, coffee and arsenious acid. Arsenic taken in small doses is of great service in the treatment of rebellious fevers with the malarial cachexia. If given in large doses, however, relapses of fever will often be produced, and the condition of the patient aggravated. Hydrotherapy is valuable, always used as a tonic medication. It succeeds sometimes when other medications have failed. It is well to know, however, that the first treatment may provoke a relapse; hence it is necessary to proceed with prudence, beginning with short and lukewarm douches before arriving at cold douches, not touching at first the spleen, and prescribing some doses of quinine at the same time. One can readily understand that a cold douche, especially if applied over the splenic region or following a paroxysm, will cause contraction of the splenic vessels, driving the hæmatozoa into the circulation, The malarial patients, who in thermal stations—Vichy, for instance—take these waters both internally and in the form of baths, often have relapses at the beginning of the treatment, when they do not proceed with prudence. The change of climate is often beneficial to these patients, because the great heat of malarial climates is very debilitating, giving rise to exhausting sweats, nights without rest, and dyspepsia—all of which are corrected in a better climate. Quinine is of invaluable service in the treatment of these fevers, especially acting as a specific in the chronic forms. It has a very powerful destructive action upon all microbes, especially upon the protozoa, to which group the hæmatozoa belong. These rapidly disappear from the blood of patients who are submitted to a course of quinine medication. The spherical bodies and the flagellate forms disappear first. The treatment must be continued for some time to insure entire destruction of the microbes. It is probable that the phagocytes invade more readily the hæmatozoa when they have been killed or benumbed by the salts or quinine, but that the activity of the phagocytes is not directly influenced by the quinine.—*La Medicine Moderne, February* 19, 1891.

THE THERAPY OF DIPHTHERIA.

BY F. LOEFFLER, M. D.

In our fight against this microbe in nature, two points are always before us: *First.* To guard against the colonization of the bacillus; in healthy subjects on the intact mucous membranes, and in diseased individuals on the mucous membrane that has not been as yet infected. This colonization can be hindered, if we bring the healthy mucous membrane into contact with some substance which will prevent the growth of the bacilli, or, better still, which will kill them, as soon as it is brought into contact with them. Of course, these substances cannot be of a nature calculated to injure the mucous membrane, or such that even a continued use of them could give rise to toxic or other unpleasant symptoms. *Second.* The clusters of developed bacilli in the superficial layers of the pseudomembrane must be killed, so that no spreading of the infection to parts of the mucous membrane, as yet intact, can take place, and also that no living bacillus may be expelled from the patient's mouth, so that the spread of the disease in other persons may be avoided.

In experimental work the bacilli should be placed in a nutritive substance congenial to them, and in which they will increase rapidly, as is the case when they are in the human mucous membrane. The temperature of the culture should also be such as to facilitate the growth of the germs. I have found the following mixture especially favorable to the growth of the bacilli: Four parts of beef-blood serum, one pint of neutralized bouillon, 1 per cent. of peptone, 1 per cent. of grape sugar, 0.5 per cent. of common salt, at a temperature of 99.5° F.

Ten cubic centimetres of this serum mixture is placed in a test-tube. The tube is held at an angle so as to allow a larger surface of the serum to be exposed to the air until it coagulates. This tube was now inoculated superficially with a fresh culture of the bacillus. In eight hours small colonies could be seen, and in twenty-four hours the whole surface of the serum was covered with a thick layer of the bacilli. Into the freshly inoculated tube, enough of the remedy to be tested was poured to cover the surface of the serum — about 10 to 15 cubic centimetres. The fluid was either immediately poured off again, or else allowed to stay in contact with the serum for ten seconds. The act of gargling can seldom be continued longer than ten or thirty seconds, and, therefore, this time was chosen in order to prove the efficacy of the drugs to be employed. The pouring in and out of the fluid did not work off the bacilli.

If a blood-serum culture is allowed to remain undisturbed for several days, it will be found that a thick layer has formed over the serum. This layer corresponds with the colonies of bacilli in the superficial membranous layers in the human subject. After the remedy had been tested upon the superficial culture of the bacilli, it was also tested in cultures several days old, in a similar manner. The time allowed for contact being twenty to thirty seconds. After the fluid had been poured off, tests were made both from the superficial and deep layers of the culture.

I discovered, in this way, that, while some remedies cause the immediate death of the bacilli in superficial cultures, they have comparatively little or no effect when the cultures have become thick layers, even when the contact is prolonged, and that in order to produce any effect the remedy had to be used in a concentrated form.

These comparative experiments seem, to me, to be of great practical value. They teach us that a prophylactic treatment with weak solutions is not sufficient, but that we must combine these with concentrated applications which will also cause the immediate destruction of the bacilli in the deeper layers.

The remedies which I have tested comprise most of those which have found, or still find, therapeutic application in diphtheria, and also other antiseptics. Some I have subjected to a most careful study, others I have only been able to pay passing attention to.

They are as follows: Bichloride of mercury, cyanide of mercury, metallic mercury, nitrate of silver, chloride of silver dissolved in sub-sulphurate of soda, permanganate of potash, chlorate of potash, saturated lime water, aqueous chlorine solutions, aqueous bromine solutions, aqueous iodine solutions, trichloride of iodine, chlorate of lime solutions, double iodide of potash solutions, alcohol, allyl-alcohol, benzyl-alcohol, ether, chloroform, carbolic acid, salicylic acid, resorcin, hydrochinon, tropæolin, benzol, brenzcatechin, the xyloles, toluol, anisol, phenetol, pseudocumol, oil of turpentine, anilin, thymol, the creosoles, creosol-sulphonic acids, and thirty-eight etheric oils.

The majority of the organic preparations were placed at my disposal by Dr. Limpricht, of our chemical institute, and my thanks are due him.

Bichloride of mercury proved its powerful antiseptic qualities also in killing the tubercle bacillus. Solutions of 1–10,000 caused immediate sterilization of a superficial culture, and even a solution of 1–20,000, when brought into contact with the cultures, caused the death of nearly all the bacilli, the few remaining ones, however, formed themselves into colonies within a few days. A 1–2,000 solution, even, when kept in contact with the cultures for twenty seconds, failed to exert any lasting influence upon the deeper layers of the culture.

The employment of a 1–1,000 solution caused the disappearance of nearly all the bacilli, and any stronger solution than this caused their complete extermination, even in the deepest layers.

My experiments with the cyanide of mercury were particularly interesting. This drug has been used in the treatment of diphtheria by Hugo Schulz, Erichsen, Rothe and others. Sellden, of Sweden, has, perhaps, had the most extended experience with it. He has used it in one hundred and fifty-six cases of diphtheria, and only lost four, three of which he came too late to relieve.

His treatment consisted in giving a spoonful of the following formula every hour, day and night:

℞

Hydrag cyan	gram,	0.02.
Tinct. aconiti	grams,	2.00.
Mel. crud	"	50.00.
Ag. dest	"	150.00.

M.

For young children 0.1 to 0.4 milligrams of the cyanide mercury was the dose employed. Then, two to four times during an hour the following gargle was employed:

℞

Hydrag cyan	grams,	0.04.
Ag. menth. pip	"	400.00.

Either of these solutions have a strength of 1–10,000. My own experiences have shown that solutions of 1–10,000 exterminate nearly all the germs, although the contact may only be momentary. In solutions of 1–8,000, the sterilization is absolutely complete. The thick cultures were not, however, sterilized even by twenty seconds' contact with a 1-1,000 solution, this result being obtainable only when a solution of 1–200 was used. All the same, repeated applications of a 1–1,000 solution will cause subsequent sterilization. Sellden's method of using the solutions every fifteen minutes or half hour would surely hinder the growth of the bacilli. This treatment, however, will not cause a destruction of the bacilli within the membranes. In one case of diphtheria I was able to trace the bacilli in the membranes (by cultures) after the cyanide of mercury solutions had been used for three weeks.

In my opinion, preparations of silver promise excellent results. Nitrate of silver in solutions of 1–1,000, when brought in contact with cultures for one to ten seconds, had a decided action. The serum would remain apparently sterile for about twenty-four hours, then, however, colonies would begin to form again. Stronger solutions of 1–150 caused complete destruction of the bacilli. The same solution had no effect upon cultures, even when kept in contact for twenty seconds.

Fresh chloride of silver, dissolved in sub-sulphurate of soda, was found by Behring to be very destructive to the gonococcus of gonorrhœa in solutions of 1–7,500. Personally I brought four cases of whooping cough to a speedy termination by inhalations of a 1–10,000 solution of the chloride. Solutions stronger than 1–5,000 are very irritating. In experimenting with this drug on serum infected with the bacillus of diphtheria, I found that ten seconds' contact with solutions of strengths, varying from 1–600 to 1–4,000, rendered the serum sterile, while the tubes tested with solutions of 1-5,000 to 1–10,000 developed small colonies the subsequent day. But on the third or fourth day, all the tests contained bacilli. In the tube treated with the 1–600 solution, the colonies were very markedly disseminated, but in the weaker solution a coating of the bacilli had formed over the serum. Indeed, this drug showed no superiority to nitrate of silver.

Permanganate of potash in a 1-per-cent. solution left enough bacilli to form new colonies within the course of a day. A 2-per-cent. solution sterilized the surface of the serum. In order to positively destroy cultures within twenty seconds, a 5-per-cent. solution was necessary, although the 3-per-cent. solution was very active.

Chlorate of potash, 5 per cent., saturated lime water, peroxide of hydrogen 1 per cent., sulphuric acid 1.25 per cent., and lactic acid 1 per cent., were entirely inactive when kept in contact for 10 seconds.

Iodine in aqueous solutions was inactive, but a solution composed of 5 parts of iodine, 10 parts of iodide of potash, and 300 parts water, sterilized cultures in 20 seconds.

Bromine in 1–300 to 1–500 solutions sterilized the serum in 10 seconds. The bacilli in cultures were only destroyed after a 20 seconds' contact with a 2.5-per-cent. solution of bromine.

Chlorine water, containing 0.009 grams of Cl. to the cubic centimetre (1–112.7) destroyed the bacilli on the serum, even in weaker solutions (1–1,100) in 10 seconds. The first-named solution also sterilized cultures in 20 seconds, but the weaker solutions had but little effect.

Although saturated lime water had been proven inactive, saturated solutions of chlorate of lime were most effective. Fifty parts of chlorate of lime were mixed with 200 parts of water. The filtrate destroyed the bacilli on the serum, even when diluted twenty-five times. The cultures, however, were only destroyed by the undiluted filtrate, in 20 seconds. Weaker solutions were almost inactive.

Behring has recently used trichloride of iodine successfully in treating diphtheria in animals, in a 1–1,000 solution. Even a 1–2,000 solution has a decided action. My own experiments showed that a 1-per-cent. solution exterminates the bacilli in cultures in 20 seconds.

Absolute alcohol destroyed nearly all the germs on the serum surface upon momentary contact, and even a 5-per-cent. solution was decidedly active. A mixture of alcohol and ether is especially valuable, and the following mixture I have proved to be most serviceable :

℞

Alcohol	50 parts.
Ether	25 parts.
Water	25 parts.

On cultures, however, both alcohol and ether gave negative results.

Allyl-alcohol gave negative results, while benzyl-alcohol sterilized the inoculated serum in 10 seconds completely. Chloroform water was equally as effectual.

Carbolic acid gave negative results in a 1-per-cent. solution. A 3-per-cent. or 4-per-cent. solution will sterilize the inoculated serum. The addition of 20–40 per cent. of alcohol greatly intensified the action of a 2-per-cent. solution. Cultures were destroyed in 20 seconds by a 5-per-cent. solution. The same results could be accomplished by a 3-per-cent. solution, with the addition of 30 per cent. of alcohol.

Lysol, which has been recently introduced into commerce, proved very efficacious. Two-per-cent. solutions sterilized the inoculated serum in 10 seconds. Cultures, however, were not positively sterilized, even by 20 seconds' contact with a 5 per-cent. solution.

The kresols were but slightly active. Salicylic acid, while active in sterilizing serum inoculations, gave negative results in cultures. Two and five-per-cent. solutions were employed.

The action of the etherial oils was especially interesting. The majority of these strongly odorous oils contain carbo-hydrogen in the form of C^{10} H^{16}, and a few contain oxygen. These actions were extremely varied. The majority of them, however, seemed to check the growth of the bacilli, even by their fumes. Anisol in a 5-per-cent. solution of equal parts of ether and alcohol was very effective. Thymol in steam form was inactive, but in a mixture with 20-per-cent. of alcohol, it killed all the bacilli upon contact — even in solutions of 1–500. The direct application of watery solutions of anilin were active on the serum surfaces. Anisol solutions were inactive. Oil of turpentine, even with the addition of 50 per cent. of alcohol, gave negative results, but the addition of 2 per cent. of carbolic acid rendered it very active.

Metallic mercury in vapor form was effective in sterilizing serum surfaces.

So much for my experiments, which, however, are far from being complete. Many of the most active agencies are, unfortunately, unsuitable for practical use, on account of their toxic qualities.

For prophylactic treatment of persons exposed to diphtheria, gargling every two or three hours, for five or ten seconds with a suitable solution, is recommended. For this purpose, I have found the following very useful: Bichloride of mercury 1–10,000, or 1–15,000, or better still, cyanide of mercury in a 1–8,000 solution, or 1–10,000. The taste of the latter preparation is less unpleasant than that of the former. Chloroform water, or thymol 1–500 in 20 per cent. of alcohol, is also useful and agreeable. It is of great importance that the gargling should be done properly and thoroughly. In vapor form, oil of orange peel, lemon oil, eucalyptus oil, anisol, phenetol, benzol and toluol, are of service. These are best used according to Feldbausch's method. A small metallic tube, containing absorbent cotton, moistened with the oil, is inserted in each nostril, and the patient is therefore continually breathing the fumes. These tubes should remain in place as long as the patient is in an atmosphere probably victated with the bacilli of diphtheria. The same oils might also be sprayed or vaporized in the sick room with material advantage. In this way the air would be more or less saturated with the fumes, and, certainly, an atmosphere in which orange peel oil, or lemon oil, is suspended, is both pleasant and refreshing.

Regarding the treatment of patients actually suffering from this dread disease, I advocate gargling every one or two hours with weak solutions, and gargling every three or four hours with solutions which will positively destroy the bacilli, even in thick cultures, For the latter purpose, I have found the following most practicable: Bichloride of mercury, 1-1,000; carbolic acid 3-per-cent. solution in 30 per cent. of alcohol, finally, equal parts of alcohol and oil of turpentine, with 2 per cent. of carbolic acid. Between the appointed hours for gargling, the parts might be painted with a 5-per-cent. solution of carbolic acid, 2 per cent. of bromine, 1 per cent. of chlorine, or with a concentrated watery solution of the kresols, especially *o*-kresol and *p*-kresol.

Bichloride of mercury has been used with the most excellent effects, and also the 3-per-cent. solution of carbolic acid in 30 per cent. of alcohol. Under the treatment described above, the membranes can be proven to be sterile within a few days. The general condition of the patient improves rapidly. Gargling with the carbolic-acid solution will at first be unpleasant to the patient, but this soon passes off, and the patient soon becomes accustomed to it. It is to be noted that, in diphtheritic scarlet fever, the above treatment is also very successful.

I trust, that, in this brief lecture, I have been able to set forth clearly the principles of the modern therapy of diphtheria, based on the most recent researches and extensive experience, and that with the advance of medical knowledge this *bete noir* of medicine may lose many of its horrors, and be able to claim but few victims.—*Exchange.*

SELECTIONS.

STUDIES ON THE ACTION OF DEAD BACTERIA IN THE LIVING BODY.

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SECOND ARTICLE.—THE ACTION OF STERILIZED CULTURES OF THE TUBERCLE BACILLUS.

We have seen in the first article that the action of bacteria in the body is by no means limited to the changes induced by those substances called ptomaines, albumoses, or toxalbumins, which are set free by living germs. It appears that the proteid constituents of the bacterial cells themselves, when these are set free, either by a natural disintegration of the germs or by an artificial extraction, are capable not only of stimulating the fixed body cells to proliferative changes, but may, by calling into play the forces involved in chemotaxis, cause either a moderate collection of leucocytes or induce marked suppuration.

It is probable that these two fairly distinct factors, the eliminated ptomaines and albumoses on the one hand, and the bacterio-proteins on the other, are both involved in many, if not most, of the acute infectious diseases. But one or other of these factors is apt to be so preponderant in many cases as to fairly dominate both the symptoms and lesions.

For example in tetanus, typhoid fever and Asiatic cholera, the toxic substances absorbed into the body at large from the seat of growth of the pathogenic germs may determine profound and even fatal symptoms without much local change at the proliferating germ centers.

On the other hand, in many of the local suppurations—in pneumonia and in tuberculosis, for example—the most marked effects are apt to be induced in the immediate vicinity of the invading germs.

In still other diseases—diphtheria, for example—we may have extreme local tissue changes together with profound systemic effects.

Finally, under a variety of unusual conditions, pathogenic germs which commonly induce one particular order of lesions may bring about most striking alterations of another class.

As an example of this variability of effect, we may cite the suppurative inflammations which not infrequently occur as complications of typhoid fever, when these germs lodge or grow in unusual situations.

Perhaps, the most striking example of a pathogenic germ whose effects are closely limited to the immediate neighborhood of its seat of growth is the *bacillus tuberculosis.* That there may be systemic effects induced by the absorption into the body at large of poisons eliminated by the tubercle bacillus, we, of course, cannot deny. But, if such there be, we certainly know very little about them, and they must be insignificant in comparison with the dominant lesion of tuberculosis—namely, the production immediately about the germs of a new short-lived tissue having a moderately characteristic morphology and prone to undergo degenerative changes of great significance, both to the germs which cause it and to the integrity of the invaded organ.

It is because of the peculiarly direct and constant relationship between the germ and the lesions which it induces that we have selected the tubercle bacillus for an experimental study along the lines which our preliminary paper has suggested.

But, before detailing our own experiments, it seems desirable to briefly notice some observations already made in this field, which will have a bearing in establishing our point of view.

A number of studies have been made on the metabolic products set free during the growth of the tubercle bacillus, both in cultures and in the body. But these studies have been made from such a variety of different standpoints and with such different technique that it is difficult to glean any very positive and definite data from the results.

Hammerschlag found in the alcohol and ether extract of the tubercle bacilli, fat, lecithin and a poison which induced spasms and death in rabbits and guinea-pigs. The residual material of the bacilli contained an albumenoid and cellulose. He could not separate a ptomaine by Brieger's method, but did find evidence of a fever-causing toxalbumin.

The recent publications of Koch on the nature and effects of substances in or derived from cultures of the tubercle bacillus we may assume to be familiar to all our readers. But the manner in which they have been made known and the lack of detail in the description of the mode of preparation of his "lymph" leave his results in a most unsatisfactory state of indefiniteness, so far as the scientific bearing of the subject is concerned. Some substance or substances, it would appear, either set free during the growth of the tubercle bacilli or, as it is said, extracted from them by glycerine, are capable of exerting rather ill-understood effects upon tubercle tissue in the body and are not without extreme effects in many cases upon the body at large. With the therapeutic bearing of the substances contained in Koch's tuberculin we have here nothing to do.

One point, however, in Koch's last publication on this subject has an important bearing upon the subject in hand—namely, the statement that pure cultures of the tubercle bacillus killed by boiling, or in other ways, are capable of inducing local suppuration with no other effects, if introduced subcutaneously into the guinea-pig.

Hueppe and Scholl cultivated the tubercle bacilli in a glycerine-peptone bouillon, and found that the fluid contained substances having essentially the same effects upon animals as those noted by Koch. As the result of an interesting series of experiments, these observers came to the conclusion that the specific poison of Koch's "lymph" did not belong to the proteins, but to some substance or substances eliminated by the bacilli during their growth and contained in the culture fluids, and which were not, as Koch asserted, extracted from the culture by glycerine. Hueppe and Scholl separated from the "lymph" which they had prepared, and which seemed to be practically identical with the "lymph" of Koch, by precipitation with alcohol, a substance which appears to contain the active ingredient of the "lymph." They separated in the same way the same substances from Koch's "lymph," and, on testing these in tubes beneath the skin of animals, they found that in both cases this substance was markedly chemotactic.

That Koch's lymph is not, as it is furnished in the crude condition, chemotactic and does not tend to cause abscesses, may be due to the fact that it contains glycerine, which exerts an influence on the leucocytes opposite to that which positive chemotactic substances display.

Trudeau, working also with fluid cultures, obtained materials apparently the result of metabolic processes of the tubercle bacilli which induced toxic effects upon animals. But these were not marked, since he did not succeed in sufficiently concentrating the fluid containing the materials sought for.

Zulzer extracted from agar cultures a substance which, on purification and injection subcutaneously in small quantities into rabbits and guinea-pigs, caused temporary increased rapidity of respiration and an elevation of temperature. Larger doses were fatal.

Crookshank separated the bacilli from glycerine-broth cultures by filtration, and concentrated the filtrate by evaporation. This concentrated filtrate, injected subcutaneously into guinea-pigs, induced muscular spasms, a lowering of the temperature, and death.

Weyl extracted tubercle bacilli with dilute caustic soda, and found in this extract a substance which seemed to him to belong in the mucin group. Subcutaneous injection of a solution of this substance produced in animals a local necrosis at the seat of injection.

Maffucci found that sterilized cultures of tubercle bacilli introduced beneath the skin of guinea-pigs in considerable amounts were capable of inducing a chronic poisoning of the organism, ending in death from marasmus and great destruction of the red blood cells in the spleen, but does not note any marked local changes beyond the producing of an abscess.

Wyssokowicz killed the tubercle bacilli in cultures by boiling, and these on subcutaneous injection in a rat caused a small local abscess, containing well-formed and readily stained though dead tubercle bacilli.

An emulsion of a boiled culture of the tubercle bacilli was injected into the abdominal cavity of a rat. The animal was killed on the thirtieth day. A few small nodules were found beneath the liver which consisted of a central pus-like mass surrounded by a thin new-formed tissue wall. The central portion of these nodules consisted of tubercle bacilli and leucocytes, while their walls were composed largely of endothelial cells, with here and there giant cells among them. Readily stained tubercle bacilli were scattered through the walls of these nodules, and the epithelioid and giant cells were often grouped about them. The microscopical examination of the liver revealed numerous small spheroidal nodules composed of epithelioid cells and leucocytes, among which were scattered a few tubercle bacilli.

We know that various kinds of substances, organic and inorganic, when introduced into the body, can become surrounded by a tissue in many respects resembling tubercle tissue. This was abundantly shown in the years just preceding the discovery of the tubercle bacillus and the final establishment of tuberculosis as an acute infectious disease. Whether the dead tubercle bacilli in these experiments of Wyssokowicz's act in some special way in stimulating the tissues to these tubercle-like growths, or whether they do this simply as foreign bodies, must be shown by further studies.

The action of the living tubercle bacillus in inducing the local lesions of tuberculosis seems to be quite complex. But there appear to be several tolerably distinct classes of influences at work.

In the first place, there seems to be an irritation or stimulation of the tissues near the bacilli which results in the proliferation of cells, primarily and notably of the connective tissue cells. The effect of this is to produce what is called the epithelioid cell tissue. Following this, or associated with it, there is a local action either on the leucocytes or the blood vessels, or both, which leads to the accumulation of small spheroidal cells either in the periphery of the tubercle or distributed through it. Generally there is a necrotizing action which results in the coagulation necrosis or cheesy degeneration of the new-formed tissue or other tissue near the tubercle.

The giant cells which form such striking features in many phases of tuberculosis appear to be formed under the influence, on the one hand, of those factors which induce cell proliferation, and, on the other, of those which retard the completion of the cell proliferation when once it is under way. The impulse to cell division under these circumstances is in so far successful that a protoplasmic mass is formed with many nuclei, but the consummation of this attempt, the division of the cell bodies, is in abeyance.

In view of the new facts regarding the singular power of the bacterio-protein and chemotaxis which the researches briefly summarized in our first article have revealed, and the promising but, it must be confessed, rather obscure light which the recent studies on the poisons of the tubercle bacillus have elicited, it has seemed to us that some further studies on the tubercle bacillus should be made with the view of learning, if possible, in more detail something of the factors which are concerned in developing the complex structures which we call tubercles and tubercle tissue.

Our first series of studies was made with the view of determining what effects, if any, are produced in the body of the rabbit by the introduction of cultures of the tubercle bacilli killed by prolonged boiling and freed from any material elaborated by them during their growth on the artificial culture media, so far as such substances are soluble in the culture media, or in water, or in 50-per-cent. glycerine. That is to say, we wished in these experiments to learn whether dead bodies of the tubercle bacilli alone, apart from any of their elimination or soluble metabolic products, produced changes in the body cells of living rabbits, and, if so, of what kind.

TECHNIQUE.—We cultivated the tubercle bacillus for this purpose on peptone agar with 6-per-cent. glycerine, and in glycerine-peptone bouillon. In all cases we continued the growth until it became voluminous, and we obtained identical results, whether the cultures were two months or six months old, and whether they were made in bouillon or on agar. We have used cultures of tubercle bacilli derived from three different sources.

The solid masses of culture were scraped carefully off from the agar, or filtered from the culture bouillon. In some cases we were not particular to remove from the cultures what culture bouillon clung to the germ masses. But in most of the experiments the masses of bacilli were washed with sterilized distilled water, and then boiled in a small amount of sterilized water for from an hour and a half to four hours. In still another set of experiments we first carefully washed the culture masses, and then boiled them for from two to four hours in 50-per-cent, glycerine with water, and then filtered off the fluid, washing the germ masses before making an emulsion with pure water for injection.

We have found that the condensation fluid in glycerine-agar cultures and also the glycerine bouillon in which the tubercle bacilli had grown, when dropped into strong alcohol, gives a white precipitate, which, according to the studies of Koch and Hueppe and Scholl, contains the active principles of Koch's tuberculin. We furthermore found that, after the glycerine-agar condensation water or the glycerine bouillon in which the tubercle bacilli are grown has been carefully washed out of the culture masses of bacilli, no more of this tuberculin-containing material is extracted from the bacilli by either water or 50-per-cent. glycerine, even after boiling for four hours. It would thus appear that the active substance in Koch's "lymph" is a material elaborated by the life processes of these germs and set free in the culture media, as shown by Hueppe and Scholl (3).

After steaming the bacilli for from an hour and a half to four hours in the steam sterilizer, and separating them from their metabolic products in the manner described, we have made an emulsion of the bacilli in sterilized water which we have used in our experiments. In a few cases we have boiled the bacilli together with a small amount of the culture fluids containing their metabolic products, but the results of these experiments have been the same as when we have carefully separated them.

We find that after prolonged boiling, either in water or in 50-per-cent. glycerine, while many of the bacilli present the usual bizarre, broken, granular involution and degeneration forms so often described, most of them preserve their form intact, and are stained in the usual way by the Koch-Ehrlich method. The broken granular forms are readily stained.

We have, by a series of separate experiments, proved that the tubercle bacilli are certainly killed by the prolonged steaming to which they have been subjected, of from an hour and a half to four hours.

As this is, of course, a point of vital importance in our experiments, we have been very careful about this preliminary sterilizing. We have used the Arnold steam sterilizer, which is one of the most efficient forms of laboratory sterilizers known to us. The material to be killed has been invariably placed in small, thin-walled flasks, exposed to the full action of live steam. The duration of the steaming was, of course, carefully reckoned from the time when the chamber of the steamer and its contents was at the full boiling temperature. While we have found in a series of preliminary experiments that an hour and a half's steaming sufficed to kill the cultures, as, from what we know of the vulnerability of these germs, it should, in all except one set of experiments, we continued the steaming from two to four hours, the average time being about two hours and a half.

The masses of tubercle bacilli thus steamed have been proved to be dead, *first,* by their failure to grow on favorable culture media; and, *second,* by the much more delicate test of repeated inoculations in guinea-pigs, which invariably gave negative results so far as the development of tuberculosis is concerned. Finally, we have inoculated guinea-pigs with materials from the lesions about to be described as induced in rabbits by the dead cultures, and obtained in the guinea-pig only negative results.

In these ways we have satisfied ourselves that the material which we were using contained in every case no living tubercle bacilli, but only their dead bodies.

EXPERIMENTS.—SUBCUTANEOUS INJECTIONS.—We first made a series of injections of the emulsion of the sterilized tubercle bacilli in rabbits beneath the skin and found that in a considerable proportion of cases a small local abscess is developed in from two to six weeks. This abscess, sometimes firmly encapsulated with fibrous tissue, contains pus cells, granular detritus, and many readily stained and well-formed tubercle bacilli, together with involution forms. This pus, as above indicated, on inoculation into that most susceptible animal, the guinea-pig, gave negative results; no tuberculosis developed, which was to be expected if the cultures of the tubercle bacilli used for inoculation had been readily sterilized. We have further made cultures of this pus with a view of determining whether this suppuration might not be due to some of the ordinary pyogenic bacteria, but the results were negative. We thus find, in consonance with the results of Koch, and of Hueppe and Scholl, that dead tubercle bacilli are, under certain conditions, markedly pyogenic.

We have tested the chemotactic powers of sterilized cultures of the tubercle bacillus introduced in tubes beneath the skin of rabbits, in the manner described in our first article, and found in every case after six days a plug of leucocytes extending deep into the broken end of the tube. We have introduced the dead cultures beneath the skin of rabbits inclosed between the laminæ of Ziegler's plates. In from three to five days the capillary space was found crammed with leucocytes. The dead tubercle bacillus thus possesses marked positive chemotactic powers.

PERITONEAL AND PLEURA INJECTIONS.—We next made injections of the emulsion of dead tubercle bacilli in considerable quantities (2 to 3 cc. of a milky emulsion) into the peritoneal and pleural cavities—in four animals into the peritoneal cavity; in two, into the pleural cavity. We obtained one positive result in each set of injections. The others were all negative.

In the positive cases, whose results were similar in both the pleura and peritoneum, we found several larger and smaller white nodules adherent to the serous surfaces. These consisted of a central soft creamy mass, made up largely of pus cells with cell fragments and granular detritus intermingled with large and smaller clusters of readily stained and well-formed tubercle bacilli. While the nuclei of some of the pus cells were not readily stained by hematoxylin, there seemed to be no evidence of well-marked coagulation necrosis in the cells except when very large masses of the dead bacilli were introduced. This central pus mass was in all cases closely surrounded and inclosed by a wall of fibrous tissue, in the inner layer of which were numerous larger and smaller masses of epithelial cells intermingled with giant cells. Some of these epithelial and giant cell islets were irregular in shape and diffuse in outline. Others were sharply circumscribed and rounded, and presented the general appearance of miliary tubercles. Tubercle bacilli were everywhere abundant in these epithelial cell masses, and nowhere else in the fibrous wall of the nodules. Well marked cheesy degeneration was nowhere seen in these cell masses which resemble tubercle tissue, even when the animal remained alive for four weeks after the injection.

We thus see that the injection of dead cultures of the tubercle bacilli is capable of occasionally inducing in the pleural and peritoneal cavity of the rabbit a suppurative focus and the formation about it of a tissue morphologically similar to tubercle tissue.

While these results are interesting, we should not forget that a great variety of substances, organized and unorganized, on introduction into the serous cavities, as well as beneath the skin, are capable of stimulating the cells of the part to the production of a new tissue which in many respects closely resembles in its morphological characters the tissue induced by living tubercle bacilli. The new tissue growths formed under these conditions have been the subject of the most extended research in times gone by. And every pathologist who lived through the epoch immediately preceding the discovery of the tubercle bacillus knows to what fallacious conclusions experimental studies on the introduction of foreign bodies into animals led many an observer, owing to the unwarrantable stress which was laid upon epithelioid cell tissue and giant cells in determining the morphology of tubercle.

We have, therefore, left this line of experiment here and turned our attention to a form of experiment which seemed to promise a more direct insight into the detailed effects of dead tubercle bacilli upon the living animal cells. This was the injection of the dead germs directly into the blood vessels of the rabbit through the ear veins.

The leading idea in these experiments was to introduce into the body the dead bacilli under such conditions that their effects upon individual cells could, if possible, be determined.

INTRAVENOUS INJECTIONS.—We have used in these experiments the sterile emulsions of tubercle bacilli described above, and have injected them in moderate quantity, aiming to introduce into each animal an amount of the material which would correspond to a spheroidal mass of the solid culture of from about one to two millimetres in diameter, diffused in about two cubic centimetres of water. In order to avoid gross vascular disturbance it is important to break up as much as is practicable the flocculent masses of the tubercle bacilli with a platinum needle before injecting them. The animals bear this injection into the blood perfectly well, and we have in our series of experiments in this way rarely observed their general health was in any way impaired up to the third week, when a small proportion of the animals have died emaciated (five out of twenty-four). The animals were killed at intervals from the first day to the second month, as follows: First, second, fifth, eighth, tenth, seventeenth, eighteenth, twenty-first, twenty-second, twenty-fifth, twenty-sixth, twenty-seventh, twenty-eighth, thirty-second, thirty-fourth, thirty-fifth, forty-eighth, sixtieth day. The organs carefully hardened in strong alcohol, the lungs being filled through the trachea. Some of the sections were stained in the usual way with hematoxylin and eosin, while others were stained for tubercle bacilli. We have experimented in this way upon twenty-four rabbits.

We deem it best to give a summarized statement of our results, rather than a detailed account of the individual experiments, because the effects of the dead bacilli vary considerably, depending upon the amount introduced and the size and vigor of the animal, and in many other less well-defined ways.

If the animal is killed within twenty-four hours after the injection of a moderate amount of dead tubercle bacilli, the organs hardened in alcohol, and sections finally stained for tubercle bacilli, it will be found that the bacilli are present in by far the largest numbers, and in the largest masses in the capillaries of the lungs. They are next most abundant in the capillaries of the liver, and may be found in small numbers in the spleen.

After the first three or four days we have been unable to find bacilli in the spleen, but they appear to continue in approximately the same numbers in the lungs and liver as at first.

We have made no examinations of the other viscera with a view of determining the presence or distribution of the bacilli in them.

We need only refer here to the experiments of Wyssokowicz (12) and others on the rapid disappearance of micro-organisms injected into the blood.*

Examinations of sections of the organs of animals killed during the first and second week after the injection usually show that, while the bacilli have largely disappeared from all the viscera except the lungs and liver, they may still be found scattered singly or in small clusters in the small blood-vessels of these organs. Their situation can usually be best made out in the capillaries of the liver. Here they may be lying apparently free against the wall of the vessel, or they seem often to be surrounded by a small quantity of a nearly homogeneous or finely granular material which may be fibrin or blood plates, or, finally, they may lie singly or in small masses inclosed in variously shaped cells.

The earliest, and throughout the experiments the most constant, lesion which we have found as the result of the venous injection of dead tubercle bacilli is the development in the lungs of from one or two to innumerable small white nodules, some invisible to the naked eye, some as large as two or three millimetres in diameter. These small nodules may appear as early as the fifth day after the injection, and persist up to the end of the second month, In the earliest days they consist of a central denser mass made up of epithelioid and giant cells, interspersed with and often surrounded by masses of small spheroidal cells resembling leucocytes.

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* The use of masses of dead tubercle bacilli in the study of multiple embolism would suggest itself as a mode of experimentation on this subject, since the differential staining enables us to locate the seat of lodgment of the emboli with much greater accuracy than is possible when small quantities of ordinary insoluble pigments are used.

Readily stained tubercle bacilli are present often in large numbers in these lung nodules, especially in and among the epithelioid and giant cells. Such a nodule with its bacilli stained is represented in Fig. 1.

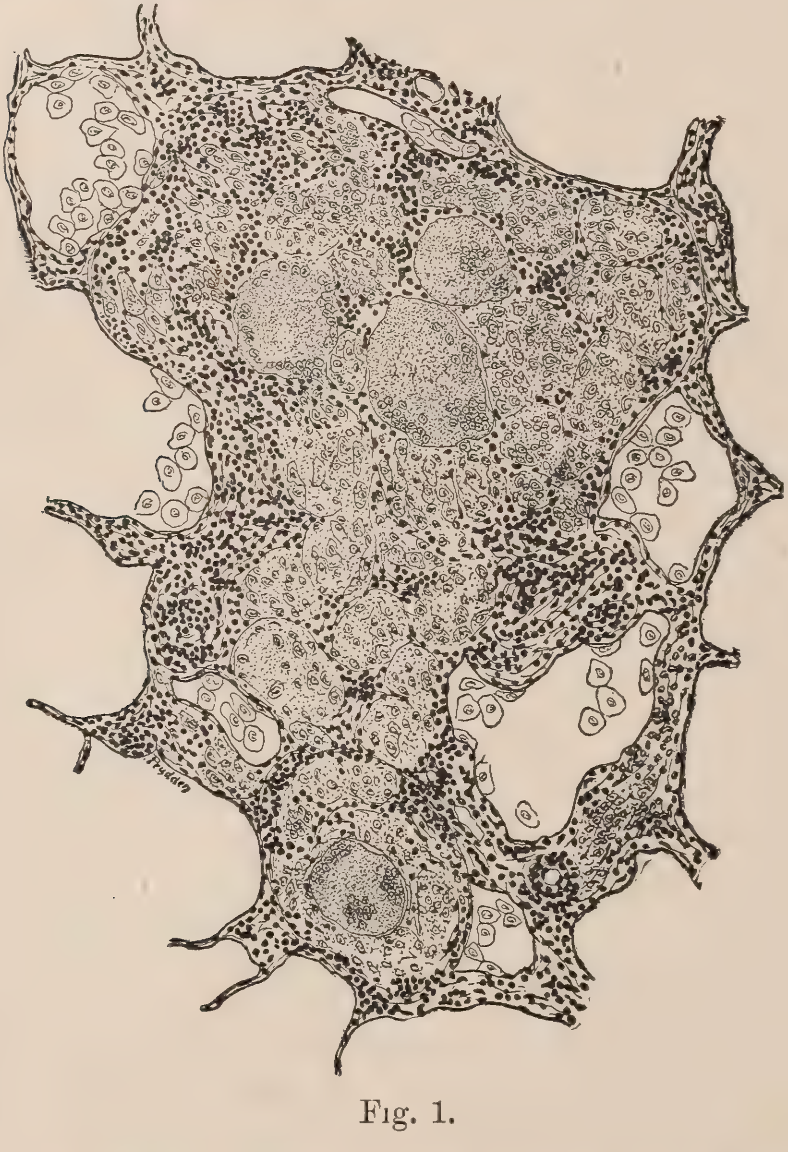

Fig. 1.

A limited area of lung tissue is replaced by these nodules, and the air-vesicles about them show an increase in the epithelioid cells, which sometimes completely fill them.

In animals killed at a later period these nodules are, as a rule, denser in texture, and consist largely of epithelioid cells and loose fibrous tissue (Fig. 2). Tubercle bacilli are now, as a rule, present in very small numbers.

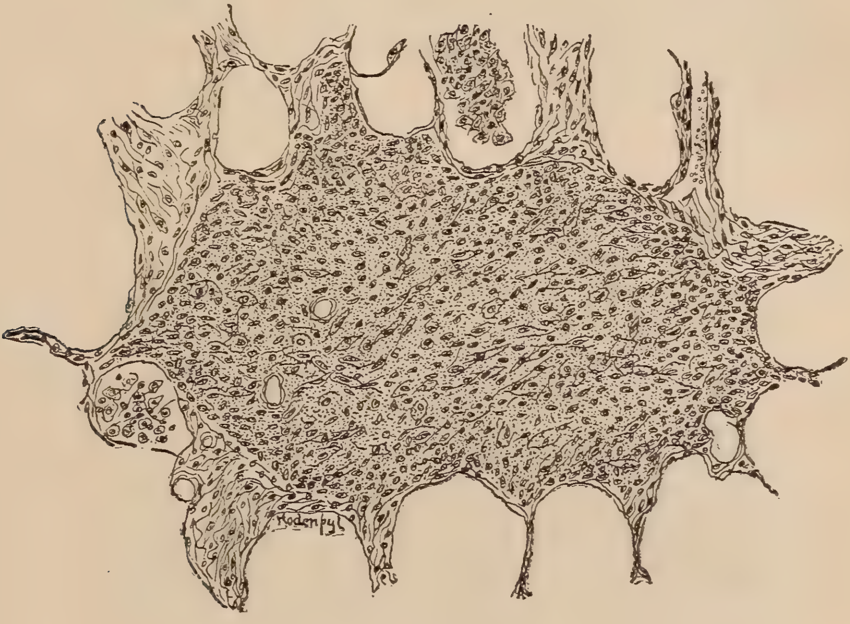

Fig. 2.

These scattered nodules in the lungs are the only lesions which we have found up to the third week; no changes, whatsoever, having been found in any of the other viscera before this time.

Animals killed in from three to five weeks almost invariably show a considerable number, often a very large number, of the above-described white nodules in the lungs, so that they look like lungs in acute miliary tuberculosis. These nodules of new-formed tissue are usually much more easily seen after the lungs have been distended with alcohol and hardened as before. In many cases animals show no other gross lesions whatsoever, either in the kidney, spleen or liver.

But if a microscopical examination of the liver is made, it will be found that in a considerable proportion of cases, as early as the third week after the injection, swollen endothelial cells are found in many of the capillaries, and scattered, often very numerous islets of new-formed cells ramify in spreading clusters in the capillaries or form very minute circumscribed masses, often consisting of but three or four cells with large nuclei and faintly granular bodies (Fig. 3). Sections showing these lesions and stained for tubercle bacilli show almost invariably one or more bacilli in these tiny new-formed cell masses. But free bacilli or bacilli inclosed in single cells are rarely to be found in the vessels, as they are in the first fortnight after the injections.

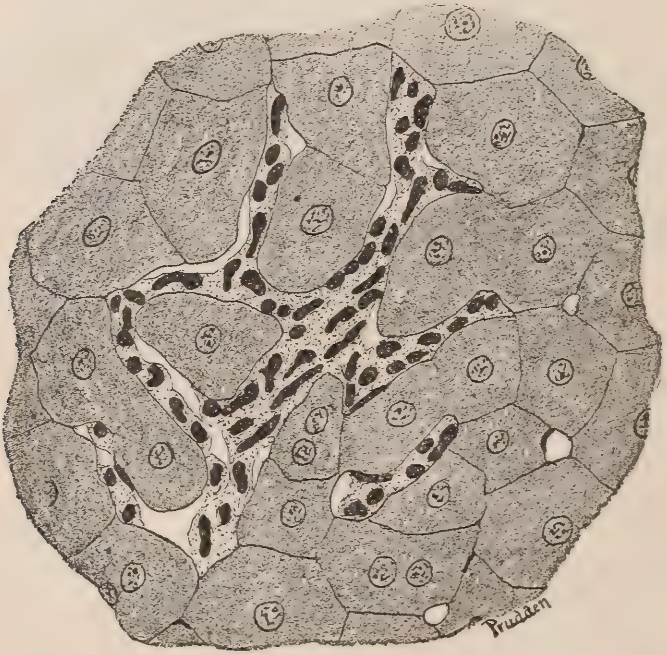

Fig. 3.

In most of the animals killed in from four to six weeks, in addition to the above-described nodules in the lungs, the liver was more or less thickly bestrewn with minute whitish spots having the gross appearance of miliary tubercles. Microscopical examination of these livers shows that, in addition to those macroscopical lesions, there are microscopical lesions of similar character.

The simplest alteration that is found at these later periods consists in a proliferation of cells within the capillaries of the liver, so that these are moderately and diffusely dilated in places, or distended, so as to contain branching nodules of epithelioid cells. It seems to us that these new cells in the capillaries are in part at least derived from the vascular endothelium.

Sometimes associated with this diffuse growth of new cells in the capillaries, sometimes without it, the whole liver is thickly sprinkled with minute, sharply circumscribed, rounded nodules. Some of these nodules consist of epithelioid cells in part sharply outlined, but in part merging into one another and intermingled with or surrounded by a zone of small spheroidal cells.

Many of the small nodules, on the other hand, consist almost exclusively of small masses of epithelioid cells, either merged together or loosely packed and distinct. Again, the nodules sometimes consist of a single small mass of epithelioid and giant cells.

Finally, the liver nodules may be more complex in structure and consist of clusters of larger and smaller epithelioid and giant-cell masses. We have seen no evidence of proliferative changes in the liver cells; but these are sometimes squeezed and flattened by the growing nodules. So numerous are these small foci of cell proliferation that not infrequently from two to ten of them may be found within the area of a section of a single liver acinus. They are usually situated within the acinus, more rarely in the interlobular connective tissue.

In the large proportion of these liver nodules a varying number of tubercle bacilli can be found. But these become less and less abundant as time goes on after the injection, so that after from a month to six weeks we have found but a few scattered bacilli in most of the nodules, and in a considerable proportion none at all. The bacilli do not appear to bear any special relation to the giant cells, as they so often do in genuine miliary tubercles. They are often considerably broken and granular.

It is most noteworthy in this connection that the tubercle bacilli are much more abundant, as a rule, before and during the early stages of the growth of these cell masses than they are when these have assumed the more distinctly tubercular type. We have found no lesions whatsoever in any of the animals, in the kidneys, and the tubercle-like masses but rarely in the spleen.

Our observations on the latter stages of these new tissue growths are not yet complete enough to enable us to state what becomes of them when the animals are allowed to live. Up to the end of the seventh week we have seen no evidence of cheesy degeneration even in the largest and most complex of the nodules. It is, perhaps, owing to the lack of cheesy degeneration that the tubercle-like bodies are often first revealed by the microscopical examination.

We do not mean to draw fast lines in assigning definite periods at which these various lesions occur after injection of the dead bacilli, but only to indicate in a general way the averages of our experiments.

We have never seen the slightest indication of the proliferation of the tubercle bacilli in the tissues of any of the injected animals.

The introduction of the dead tubercle bacilli in larger quantity and in as large masses as can be used without killing the animals by multiple embolism leads to some strikingly different results from those which we have described ; but this series of experiments is not yet completed and need not be further considered here.

SUMMARY.—We have found that prolonged boiling, while often causing a considerable breaking up of the tubercle bacillus, does not interfere with its characteristic staining and does not alter the morphology of many of the individuals of a culture ; so that bacilli killed in this way and introduced into the body can be readily recognized at their seat of lodgment, even after the lapse of many weeks.

Our experiments have shown that dead tubercle bacilli separated from such of their metabolic products as are set free in the culture media or are extracted by prolonged boiling in water or 50-per-cent. glycerine are capable of inducing marked effects upon the body cells of the rabbit with which they are brought in contact.

These dead tubercle bacilli are markedly chemotactic. When introduced in considerable amount into the subcutaneous tissue or into the pleural or abdominal cavities, they are distinctly pyogenic, causing aseptic localized suppuration. Under these conditions they are capable, moreover, of stimulating the tissues about the suppurative foci to the development of a new tissue closely resembling the diffuse tubercle tissue induced by the living germs.

We have found that dead tubercle bacilli introduced in small numbers into the blood-vessels of the rabbit largely disappear within a few hours or days, but that scattering individuals and clusters may remain here and there in the lungs and liver, clinging to the vessel walls for many days without inducing any marked changes in the latter. After a time, however, earliest in the lung ; later, as a rule, in the liver ; a cell proliferation occurs in the vicinity of these dead germs which leads to the formation of new multiple nodular structures bearing a striking morphological resemblance to miliary tubercles. There is in them, however, no tendency to cheesy degeneration and no evidence of proliferation of the bacilli, but rather a steady diminution in their number. It seems to us that the new structures originate in a proliferation of the vascular endothelium under the stimulus of the dead and disintegrating germs.

CONTROL EXPERIMENTS.—It will no doubt appear to others, as it did at first to ourselves, as if there must have been some experimental error in the attempts to kill the bacilli, so singular are the results that we have obtained. But we think that the treatment to which the bacilli used in these experiments have been subjected, together with the tests of death to which we have exposed them, make it evident that we have actually used dead germs for our injections.

This would appear certain, not only from the tests which we have detailed above, but also from the fact that we have made fresh boilings for each set of experiments (twelve in number), and in most cases have prolonged the boiling for from one to three hours beyond the period which has been established as fatal to these germs. It should be remembered that, according to the researches of Schill and Fischer, the action of moist heat at 212° F. for fifteen minutes suffices to kill tubercle bacilli.

The question now arises whether these curious effects of dead tubercle bacilli upon the living tissues of the rabbit are due to some special peculiarity of the bodies of these particular germs, or may be induced by other dead germs or other substances introduced in the same way.

To satisfy ourselves on this point, we have made a series of intravenous injections in approximately similar amounts of boiled cultures of the *bacillus diphtheriæ* of Loeffler (six animals); of the *bacillus coli communis* (five animals); of the *staphylococcus pyogenes aureus* (six animals); of wheat flour (two animals); and of red pepper (two animals). These substances have been introduced aseptically. The details of these control experiments need not be given here, since in none of them were there any alterations in any way comparable to those so nearly uniformly induced by the dead tubercle bacilli, and in most of them there was no reaction or change at all.

The animals under experiment were strictly isolated and kept under favorable hygienic conditions, so that the possibility of a chance tuberculosis is largely barred out.

We must, therefore, conclude that the lesions caused by the introduction of dead tubercle bacilli into the body of rabbits are due to some peculiar property of the bodies of this species of germ.

REMARKS.—Two possibilities, at least, exist as to this peculiar power of these dead tubercle bacilli. It may, of course, possibly be due to some trace of poison elaborated in the germ cell during its life and not given up in the culture medium, or extracted by boiling in water or dilute glycerine. Or, which seems more probable to us, in view of the peculiar properties which the bacterio-protein of other species of germs has been recently shown to possess, the remarkable power of these dead germs may be due to the specific proteid of the germ cells, which is gradually set free as the germs disintegrate at their seat of lodgment in the tissues.

Though we have made repeated attempts to isolate the bacterio-protein from the tubercle bacilli by the method of Necki, neither with this nor with any other method have we succeeded.

It seems to us highly probable that the bacterio-protein of the tubercle bacillus, either living or dead, when set free by disintegration in the tissues, is capable of furnishing that local cell stimulus which results in the formation of the various phases of those structures which we call tubercles and tubercle tissue. The slow growth of these structures would correspond to the exceptional structural invulnerability of the tubercle bacillus.

These structures, which, as we have shown, we can induce at will in the rabbit by the injection of dead tubercle bacilli into the blood vessels, are morphologically absolutely typical of certain phases of miliary tubercles, even to the presence of stainable tubercle bacilli in them. Miliary tubercles these structures are, but—and this is of vital importance—the animals do not acquire tuberculosis. It is not an acute infectious disease which we thus impart; there are no living germs to grow. The disease, if it is a disease, is not indefinitely progressive. The dead bacilli seem to act as foreign bodies simply, curiously stimulating, it is true, but only dead foreign bodies after all.

There is no tendency that we can observe in these tiny nodules to cheesy degeneration.

So far as we can see at present, when the limited amount of stimulant or poison, proteid or other, which they contained when we put them into the animal, is used up, the active process is over, and it rests with the recuperative powers of the animal to make what disposal they can of the local ravages which have been caused.

The drawings of the liver of rabbits injected through the veins with *living* tubercle bacilli by Yersin show at a glance the essential difference between the genuine miliary tubercle of tuberculous rabbits, and the non-infectious aseptic tubercles of our experiments — namely, the actively proliferating tubercle bacilli which make the lesion in the first case a progressive one, and which, sooner or later, cause the death of the animal.

These studies would suggest the possibility that the formative tissue changes which are characteristic of tuberculosis in man, may be largely due to the action of the bacterio-protein of the tubercle bacillus set free as the germs die and disintegrate in the tissues, while, on the other hand, the equally important and in some ways more characteristic action of the germ — namely, the coagulation necrosis, and possibly some of the vascular changes and other poisonous effects — may be chiefly induced by those freed metabolic products of the life processes of the germ which the experiments of Koch have recently brought to light, or to others as yet unknown.

We resist the temptation to elaborate here the many fascinating possibilities which these studies suggest as to the *rationale* of tubercular inflammation in man, and the closer analysis of its lesions which may be possible in the future.

If the results of our experiments are confirmed by others, it is evident that our conception of the significance of the various lesions of tuberculosis may be considerably modified, and the therapeutic possibilities made essentially clearer. It will be quite comprehensible why so many well-defined miliary tubercles, so many masses of tubercle tissue, so many destructive lesions of chronic phthisis, and so many so-called scrofulous and tubercular lymph nodes fail to show the presence of tubercle bacilli, if it is established that the morphological characteristics of these structures are dependent upon the disintegration of the bacilli which once found lodgment where they form.

We are aware of the danger of drawing far-reaching inferences from a single series of experiments. But we think that we are fairly justified, from the experimental data now set forth, in the conjecture that we may have here the explanation of the comparatively slow growth of tubercle and tubercle tissue, which is observed under a variety of conditions.

One may conjecture, too, whether a certain number of the miliary tubercles, which we find in the body after a generalization of the tubercular process from an old tubercular focus, may not actually be innocuous growths, or at least harmful only as foreign bodies in the tissues where they develop.

The possibility would, furthermore, suggest itself, that those dense masses of fibrous tissue in the lungs, which we usually regard as evidence of healed tuberculosis, may actually be innocuous, even though they harbor stainable tubercle bacilli, and no longer capable of lighting up a fresh infection, as is commonly supposed.

One may legitimately query, too, whether, in the closer analysis of the tubercular processes in the future, we may not find that the formation of the new tissue, the development of the tubercles themselves, is, after all, an attempt at a conservative process on the part of the organism, incited by the stimulus of the disintegrating bodies of some of the germs. It may be, too, that, as Hueppe suggests, the conservative attempt is often rendered futile by a destructive tendency— cheesy degeneration —developed under the influence of a metabolic product of the living and growing germs which the tubercular foci still harbor. The bearing of this possibility upon the administration of large doses of Koch's tuberculin should not, perhaps, be wholly ignored, even at this stage of our knowledge.

It is somewhat curious to notice how closely in accord with some of our experimental results are many of the features of Hueppe's recent essay to develop a rational explanation, on theoretical grounds, of the varied phases of the development of tubercles and tuberculosis.

We wish, in conclusion, to call renewed attention to the fact, too often overlooked, that the acute infectious diseases are much more complex, both in their lesions and their etiology, than we are wont to realize. We were formerly, perforce, content when we had done what we could to make plain the morphology of their obvious lesions. Light dawned at last on the relationship of bacteria to some of these diseases, and the definite establishment of the constant and inevitable relationship between some specific germ and its special disease, was at first so satisfying that this relationship alone was regarded as a solution of its etiology.

But, the restless seeker after detail was not long content with this, and new light was speedily forthcoming as to the important *role* which chemical poisons, elaborated by pathogenic germs, had to play in the induction of the varied phenomena of this class of diseases. We have seen that a new phase of our knowledge is being now developed in the study of the proteid ingredients of the germ bodies.

But beyond all these lines of study, and essential to their full fruition, is the development of a fuller comprehension of the powers and reactions and idiosyncracies of the body-cells themselves, upon whose comportment in the last analysis depend the distinctive features and the ultimate significance of the acute infectious diseases.

Thus, the harvest garnered in this newly opened field of thought and research must ultimately be brought home to the old storehouse of pathological anatomy and physiology, before it can be made in the fullest degree available for the understanding and curtailment of bacterial disease.—*New York Medical Journal.*

THE CHEMICAL FACTORS IN THE CAUSATION OF DISEASE.

LECTURE DELIVERED AT THE POST-GRADUATE MEDICAL SCHOOL OF CHICAGO, BY VICTOR C. VAUGHAN, M. D., PH. D., OF ANN ARBOR, MICH.

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(Continued from June number.)

LECTURE II. THE BACTERIAL POISONS OF SOME OF THE INFECTIOUS DISEASES.

An exact classification of the chemical factors in the causation of the infectious diseases can probably not be made at present. We know of two chemically distinct classes, one of which contains substances which combine with acids, forming chemical salts, and which, in this respect, at least, correspond with the inorganic and vegetable bases. The members of this class are designated as ptomaines, a name suggested by the Italian toxicologist, Salmi, and derived from the Greek word ητωμα, meaning a cadaver. A ptomaine may be defined as a chemical compound which is basic in character and which is formed by the action of bacteria on organic matter. On account of the basic properties, in which they resemble the vegetable alkaloids, ptomaines may be called putrefactive alkaloids. They have also been called animal alkaloids, but this is a misnomer, because, in the first place, some of them are formed in the putrefaction of vegetable matter ; and in the second place, the term "animal alkaloid" is more properly restricted to the leucomaines, those basic substances which result from tissue metabolism in the body. While some of the ptomaines are highly poisonous, this is not an essential property, and others are wholly inert. Indeed, the greater number of those which have been isolated up to the present time do not, when employed in single doses, produce any apparently harmful effects. Brieger restricts the term ptomaine to the non-poisonous basic products, and designates the poisonous ones as "toxines." This is a classification, however, which seems to be of questionable utility. It is not always easy to say just what substances are poisonous and what are not. The poisonous action of a substance depends upon the conditions under which, and the time during which, it is administered. Thirty grains of quinine may be taken by a healthy man during twenty-four hours without any appreciable ill effect, yet few of us would be willing to admit that the administration of this amount of quinine daily for three months would be wise or altogether free from injury. In the same manner the administration of a given quantity of a putrefactive alkaloid to a dog or guinea-pig in a single dose may do no harm, while the daily production of the same substance in the intestine of a man, and its absorption continued through weeks and possibly months, may be of marked detriment to the health. We do not as yet know enough about the physiological or toxicological action of the putrefactive alkaloids to render the classification proposed by Brieger worthy of general adoption.

All ptomaines contain nitrogen as an essential part of their basic character. In this they resemble the vegetable alkaloids. Some of them contain oxygen, while others do not. The latter correspond to the volatile vegetable alkaloids, nicotine and coniine, and the former correspond to the fixed alkaloids.

Since all putrefaction is due to the action of bacteria, it follows that all ptomaines result from the growth of these micro-organisms. The kind of ptomaine formed will depend upon the individual bacterium engaged in its production, the nature of the material being acted upon, and the condition under which the putrefaction goes on, such as the temperature, amount of oxygen present, and the duration of the process.

A second class of the chemical factors in the causation of the infectious diseases embraces the so-called poisonous albumins. In 1886, Mitchell and Reichert published the results of their investigations into the nature of the venom of serpents, from which they concluded that the poisonous constituents are peptones and globulins. Of the latter they reported the presence of three varieties, each of which is toxical in its action. Although it had been known before this that the injection of any considerable amount of artificially prepared peptone directly into the blood is followed by markedly deleterious effects, this was the first demonstration of the possession of characteristic toxicity by any of the proteids, and from the report of Mitchell and Reichert we may date all modern studies, at least, of the poisonous albumins.

In 1887, Sewall found that tolerance to the venom of the rattle-snake could be established in pigeons by the inoculation of a very small quantity and gradually increasing the amount. In this manner a pigeon was found to bear without ill effect seven times the amount ordinarily fatal to the same animals. The immunity thus obtained was observed to gradually diminish after the discontinuance of the inoculation. However, after five months, while the larger amounts reached in the last injections proved fatal, the ordinarily fatal dose was without effect.

Salmon and Smith protected pigeons against the germ of hog cholera by previous injections with cultures of the same organism which had been sterilized by exposure to a temperature of from 136.4° F. to 140° F. for one hour. However, since these cultures contained one or more ptomaines, as well as the poisonous albumins, it could not be, at that time, at least, said to which of these constituents the immunity was due.

To Christmas, I believe, is due the credit of first showing the presence of active proteids in bacterial cultures. In 1888, this investigator obtained from cultures of the staphylococcus pyogenes aureus a proteid body which, when injected into the anterior chamber of the eye or under the skin, caused suppuration.

We will now give our attention to the chemical poisons, both the ptomaines and the albumins, of some of the infectious diseases, and in doing this we will illustrate and substantiate the statements made in the preceding lecture.

ANTHRAX.—The definition of an infectious disease, as we have given it, is well illustrated by the facts which have been learned concerning the causation of anthrax, which has, probably, been more thoroughly studied than any other infectious disease. Kausch taught that this disease had its origin in paralysis of the nerves of respiration. Upon the cause of this paralysis he gave us no information. Delafond thought that anthrax has its origin in the influence of the chemical composition of the soil, affecting the food of animals and leading to abnormal nutrition. The investigations of Gerlach, in 1845, demonstrated the contagious nature of the disease, which was emphasized by Heusinger in 1850 and accepted by Virchow in 1855. However, as early as 1849, Pollender found numerous rod-like micro-organisms in the blood of animals with the disease. This observation was confirmed by Brauel, who produced the disease in healthy animals by inoculations with matter taken from a pustule on a sick horse. Attempts were made to ridicule the idea that these germs might be the cause of the disease, and it was said that the bodies seen were only fine shreds of fibrins or blood crystals. Some claimed that the rod-like organisms reported were due to defects in the glass, while others claimed that the defects existed in the eye of the observer, and others still suggested that the defects might be found back of the eye and in the brain. But, in 1863, Davaine showed that these little bodies must have some causal relation to the disease, inasmuch as his experiments proved that inoculation of healthy animals with the blood of those sick with anthrax produced the disease only when taken at a time when the blood contained these organisms. He also demonstrated beyond any question that these rod-like bodies are bacteria, capable of growth and multiplication. The conclusions of this investigator were combated by many; but Pasteur, Koch, Bollinger, De Barry and others studied the morphology and life history of these organisms, and then came the brilliant results of Pasteur and Koch in securing protection against inoculation anthrax by the vaccination of healthy animals with the modified germ and subsequent inoculation with the virulent form. Now, the bacillus anthracis is known in every bacteriological laboratory, and by inoculation with it the disease is communicated at will to susceptible animals. But here the question arose, how do these bacilli produce anthrax? and in answer to this question the various theories which we have mentioned were proposed.

The first successful attempt to study the chemical poisons of anthrax was made by Hoffa, who obtained from pure cultures of the bacillus small quantities of a ptomaine which, when injected under the skin of animals, produces the symptoms of the disease and death. This substance causes at first increased respiration and action of the heart, then the respirations become deep, slow and irregular. The temperature falls below the normal; the pupils are dilated, and a bloody diarrhœa sets in. On section the heart is found contracted, the blood dark, and ecchymoses are observed on the pericardium and peritoneum. Hoffa names his poison anthracin.

It has been said that Hoffa's work was the first successful attempt to study the chemical poisons of anthrax. However, his results cannot be considered altogether satisfactory. The small amount of the basic substance which he obtained rendered it highly probable that in the case of a germ so virulent as that of anthrax there must be other chemical poisons produced. This supposition has been confirmed by the labors of Hankin who, in 1889, while at work in Koch's laboratory, prepared from cultures of the bacillus anthracis an albumose which when employed in comparatively large amount proved fatal to animals, but when used in very small quantity gave immunity against subsequent inoculations with the living germ. Unfortunately, Hankin does not mention the symptoms induced by toxical doses of this substance. Whether or not the albumose of Hankin contains *in statu nascendi* the base of Hoffa, and owes its poisonous properties to the same, has not been determined. There is yet a promising field for research in the chemistry of this disease.

ASIATIC CHOLERA.—There are good reasons, apart from experimental evidence, for believing that the comma bacillus of Koch produces its ill effects by the elaboration of chemical poisons. This germ is not a blood parasite. It grows only in the intestine, and the symptoms of the disease and death must result from the absorption of its poisonous products. In confirmation of this statement, experiment has shown that this is one of the most active, chemically, of all known pathogenic germs.

In the first place, Bitter has shown that the comma bacillus produces in meat-peptone cultures a peptonizing ferment, which remains active after the organism has been destroyed. Like similar chemical ferments it converts an indefinite amount of coagulated albumin into peptone. It is more active in alkaline, than in acid solutions, thus resembling pancreatin more than pepsin. This resemblance to pancreatin is further demonstrated by the fact that its activity is increased by the presence of certain chemicals, such as sodium carbonate and sodium salicylate. That a diastatic ferment is also produced by the growth of the bacillus was indicated, in the experiments of Bitter, by the development of an acid in nutrient solutions containing starch paste. However, all attempts to isolate the diastatic ferment were unsuccessful. A temperature of 140° F. destroys or greatly decreases the activity of ptyalin, and this seems to be true also of the diastatic ferment produced by the comma bacillus. But the formation of an acid from the starch presupposes that the starch is first converted into a soluble form.

Rietsch believes that the destructive changes observed in the intestines in cholera are due to the action of the peptonizing ferment.

Cantani injected sterilized cultures of the comma bacillus into the peritoneal cavities of small dogs and observed after from one-quarter to one-half hour the following symptoms: Great weakness, tremor of the muscles, drooping of the head, prostration, convulsive contractions of the posterior extremities, repeated vomiting and cold head and extremities. After two hours these symptoms began to abate, and after twenty-four hours recovery seemed complete. Control experiments with the same amounts of uninfected beef-tea were made with negative results. The cultures used were three days' old when sterilized. Older cultures seemed less poisonous and a high or prolonged heat in sterilization decreased the toxicity of the fluid. From these facts Cantani concluded that the poisonous principle is volatile, but the effect of high or prolonged heat in diminishing the toxicity was more probably due to its destructive effect on the poisonous proteids.

Brieger succeeded in isolating from cultures of the comma bacillus in meat broth two basic substances which he considers the specific poisons of cholera. One of these, found in the mercuric chloride precipitate, is a diamine, resembling trimethylenediamine. It produces muscular tremor and heavy cramps. In the mercury filtrate was found another poison, which, in mice, produced a lethargic condition ; the respiration and heart's action became slow, and the temperature sank, so that the animal felt cold. In some instances there was a bloody diarrhœa.

Later Brieger and Fraenkel have obtained a cholera-albumin which proves fatal to guinea-pigs after two or three days, but is without effect upon rabbits.

More recently Winter and Lesage treat a bouillon culture of the cholera germ with sulphuric acid, dissolve the precipitate in an alkaline medium, reprecipitate with acid, and redissolve in ether, which on evaporation leaves oily drops, which, on cooling, form a yellow mass of the appearance of a fat. This substance is insoluble in water and acids, soluble in alkalies and ether. It melts at 122° F., and does not lose its virulence on being boiled with alcohol rendered feebly alkaline. The virulence of a culture and the amount of this substance contained therein are in direct proportion to each other.

Small doses of this substance (one milligram to 100 grams of body weight of the animal) in feebly alkaline solution introduced into the stomachs of guinea-pigs cause, as a rule, within from four to six hours, a chill, and death after twenty-four hours. With larger doses the temperature falls after from one-half to one hour, and death results within from twelve to twenty hours. Smaller doses cause a less marked reaction and the animal recovers within twenty-four hours. If killed within this time the animal shows a choleraic condition. Rabbits succumb only after repeated subcutaneous injections. The substance can be extracted from the muscles, liver, kidneys and urine of the poisoned animals. This substance can also be obtained from cultures of a cholera-infantum germ. The fact that this poison belongs neither to the ptomaines or albumins is of interest.

CHOLERA INFANTUM.—The fact that Booker, Escherich and other investigators have failed to find any one germ constantly present in the bowels or stools of children suffering from summer diarrhœa was mentioned in the preceding lecture. Notwithstanding this, the fact that chemical poisons are concerned in the production of these diarrhœas has been abundantly demonstrated. In the first place the symptoms of the choleraic form of these diarrhœas are so very similar to those induced by a number of gastro-intestinal irritants, which at the same time depress the nerve centers, that the suggestion that the disease might be due to chemical poisons has been favorably received by the profession. The poisonous substance first found by the writer in cheese and afterwards in ice-cream, milk and various milk preparations, and which is known as tyrotoxicon, induces symptoms which cannot be distinguished from those of choleriform diarrhœa in infants. Moreover, the *post-mortem* appearances are very much alike, if not identical, and the poison has been found in a sample of milk, a part of which had been given to a child not more than two hours before the first symptoms of a violent attack of the disease manifested themselves.

Tyrotoxicon, however, is only one of the poisons which may appear in milk and milk products, or may be formed in the intestines of the infant and cause an exhausting diarrhœa. I have recently isolated from samples of poisonous cheese, in which tyrotoxicon could not be detected, a poisonous albumin.

I have also isolated from pure cultures of the germs x, a and A of Booker's list of summer diarrhœa micro-organisms, three poisonous bodies, small quantities of which injected under the skin of kittens and puppies cause retching, vomiting, purging, collapse and death. Ten milligrams of the dried proteid from "a" killed a large guinea-pig within twelve hours, and a smaller amount proved fatal, in other experiments, after a longer time. These poisons differ from one another, more or less, in their physical and chemical properties, but all produce the above-mentioned symptoms. It may be that a more exact study of the effects induced will enable us to distinguish, in this way, one from the other. Evidently, here are three germs differing from one another morphologically sufficiently to be classified as different species, but belonging chemically and toxicologically to the same group. How many more of the long list of bacteria found by Booker, Escherich and others in the study of these diseases remains to be ascertained. There is no reason, however, for supposing that, in taking three of these at random, I have hit upon the only toxicogenic ones.

The fact that Baginsky's cholera-infantum germ produces a poisonous albumin was referred to in the first lecture ; also the formation of a choleraic poison by the germ of Lesage has been mentioned in discussing the chemical poisons of Asiatic cholera.

The prevention of the summer diarrhœas of infancy becomes a more difficult task than those who believe that a single micro-organism is concerned in their causation admit. All bacteria which are capable of growth and reproduction within the intestines of the infant, and of the production of chemical poisons during their development, must be excluded. The treatment of the same diseases will not be wholly successful until we know how to antidote these poisons. To accomplish these ends will probably require many years of research and observation by our profession. However, if this be the right line, let us follow it, realizing that our successors will profit by our mistakes, and render our partial successes more successful.

DIPHTHERIA.—Roux and Tersin rendered cultures of Loeffler's bacillus of diphtheria sterile by filtration through porcelain, and injected thirty five cubic centimetres of the filtrate into the abdominal cavity of guinea-pigs. No immediate effects were observed, but, after two or three days, the animals refused to eat, passed bloody urine, showed muscular weakness in the posterior extremities, manifested marked irregularity in respiration and died after from five to six days. Section showed marked renal hyperæmia and serous exudation in the pleura. In cases of less acute intoxication, paralysis of certain groups of muscles become apparent.

The cultures first employed were seven days old. Older cultures (six weeks) contain more of the poison, and the symptoms appear within a few hours after the injection. In cultures especially rich in the poison, a small amount (from 0. 2 to 2. cc.) injected under the skin suffice to induce the symptoms. The place of injection becomes œdematous, the respiration rapid, and death results as quickly as after inoculation with the germ. Mice and rats are markedly insusceptible, but succumb to large doses.

The action of this poison was found to be much lessened by continued exposure to a temperature of only 136.4° F. These investigators believed that this poison belonged to the group of enzymes.

Brieger and Fraenkel have continued the study of the chemical poison of the Loeffler bacillus. These investigators find that this poison can be heated to 122° in the presence of an excess of hydrochloric acid without being destroyed and they conclude from this that the substance cannot be an enzyme or ferment. The poison is precipitated from the culture, after sterilization, by filtration through porcelain, by absolute alcohol, slightly acidified with acetic acid. It forms a snow-white, amorphous mass. It stands very closely related to serum-albumin. It may also be precipitated by saturation with ammonium sulphate, and can be purified by removing the sulphate by dialysis. This reaction distinguishes it from the peptones. In small doses (two and one-half milligrams per kilogram body weight), injected into the blood-vessels, it causes death, not like other poisons, immediately, but after days, weeks or months, with the formation of abscesses and necrotic tissue at the point of injection, with progressive emaciation and paralysis. Brieger and Fraenkel propose for this and similar bodies the name "toxalbumin." As was stated in the first lecture, these studies leave no room for us to doubt that the Loeffler bacillus is a cause of diphtheria. The chemical poisons of Prudden's streptococcus and of the germ found by Klein in the diphtheria of some of the lower animals, have not been investigated.

Suppuration.—The fact that a pus-producing chemical poison was found in cultures of the staphylococcus pyogenes aureus had been already noted. In addition much interesting work on the poisons of suppuration has been done. That the ptomaines, cadaverine and putrescine, of Brieger, when injected under the skin in sterile solutions, cause abscesses, has been known for some years. It has been shown that sterilized cultures of a number of different germs produce suppuration. Thus, Buechner showed that sterilized cultures of the bacillus of Friedlander contains pyogenetic substances, and when injected into man in very dilute solution produce an elevation of temperature. In view of the fact that so much has been said about the wonderful effect of small doses of the so-called cure for tuberculosis proposed by Koch, the following account of an experiment made upon himself and reported by Buechner early in 1890 may be of interest: Five-tenths of a cubic centimetre of a sterilized very dilute emulsion of Friedlander's bacillus was injected under the skin of the forearm, after it had been found that five hundred times this quantity, reckoned per kilogram of body weight, caused no local irritation or suppuration in a rabbit. One and one-half hour after the injection sharp pain extended along the arm to the axilla. One-half hour later there was a chill followed by a fever which reached a maximum of 97.8° F. in the axilla five hours after the injection. At the same time the pulse arose to 108. On the following day there were well-marked erysipelatous swelling and redness extending over an area larger than a saucer about the place of inoculation, and there was marked redness along the lymphatics of the arm. On the third day all these symptoms disappeared.

Buechner has shown that the cells of seventeen different species of bacteria contain pyogenetic substances. The cells may be boiled for hours, their substance dissolved in dilute alkali and precipitated by acid without losing its pyogenetic properties. It should be understood, however, in this case that the active substance is contained within the bacterial cell, and this leads us to distinguish between the chemical poisons which arise from bacterial activity and are found in solution in cultures, and those which reside within the cell and form an integral part of the same. Buechner finds this active substance within the cell to be proteid in character. It gives the biuret, Millon's and xanthroprotein reactions. Before the substance can cause suppuration within the body it is most likely necessary for the bacterial cells to suffer disintegration. It is hardly necessary to add that the pus formed by this bacterial proteid is germ-free.

Typhoid fever.—The poisons of this disease are both basic and proteid, though those belonging to the latter group seem to be the more virulent.

In 1885, Brieger obtained from pure cultures of the Eberth bacillus a ptomaine, which produced in guinea-pigs a slight flow of the saliva, increased frequency of respiration, dilatation of the pupils, profuse diarrhœa, paralysis and death within twenty-four to forty-eight hours. *Post-mortem* examination showed the heart in systole, the lungs hyperæmic and the intestines contracted and pale. Brieger was at first inclined to regard this as the specific poison of typhoid fever and named it "typhotoxine." However, he obtained with this substance no elevation of temperature.

In 1887, Novy and the writer obtained from cultures of a germ found in drinking water, which had been the supply of many persons who had typhoid fever, an extract which, when injected under the skin of cats, caused an elevation in the temperature of from two to four and one-half degrees.

In 1889, the writer obtained, from mixed cultures made from typhoid stools, a small amount of a basic substance which caused, in the lower animals, an elevation of temperature accompanied by a profuse diarrhœa.

Brieger and Fraenkel obtained, from cultures of the Eberth bacillus, a poisonous albumin, but have reported no particulars concerning its action. The writer has two germs, obtained from drinking water supposed to have caused typhoid fever, and which, after having been kept for some days at a fever temperature, give all the reactions which have hitherto been supposed to be characteristic of the Eberth bacillus. From pure cultures of each of these he has isolated highly poisonous proteids, which, in dogs, cause a chill, followed by marked elevation of temperature. These poisons are soluble in water, from which they are not precipitated by heat or nitric acid, singly or combined. They are precipitated by saturating the aqueous solution with ammonium sulphate, and are not, therefore, peptones. They are not precipitated by carbonic acid gas, or by sodium sulphate to saturation, and this excludes them from the class of globulins. The aqueous solutions respond to the xanthroprotein and biuretic reactions. Chemically I can so far distinguish no difference between the poisonous albumins produced by the two germs, but physiologically there is a marked difference. That from bacillus A produces paralysis of the voluntary muscles, which is preceded in some animals by most violent convulsive movements. With the proteid of bacillus B neither the convulsions nor the muscular paralysis has been observed. The animal seems to die from gradual failure of the heart. However, these poisons demand a much more extensive and exhaustive study than has yet been made. It will be seen from what has been said, that the chemistry of typhoid fever promises to be both fertile and interesting in results.

TETANUS.—Brieger has obtained, from the mixed cultures of the germs of Nicolaire and Rosenbach, four poisonous substances. The first, tetanine, which rapidly decomposes in acid solutions, but is stable in the presence of free alkali, produces tetanus in mice when injected in quantities of only a few milligrams. The second, tetanotoxine, produces tremor, followed by severe convulsions. The third, to which no name has been given, causes tetanus, accompanied by a free flow of the saliva and tears. The fourth, spasmotoxine, produces heavy convulsions.

Later, the same investigator extracted tetanine from an amputated arm of a man with tetanus. This is of special importance, since it answers the assertion made by Baumgarten, that there is no proof that the poisons which have been obtained from artificial cultures are formed within the body of man.

From pure cultures of the tetanus bacillus of Kitasato, Brieger and Fraenkel have isolated a poisonous proteid, and, with cultures of another bacillus, Tizzoni and Cantani have been equally successful. These investigations leave us without cause to doubt that the convulsions of traumatic tetanus are due to one or more spinal poisons, and the causal relation of a given bacillus is determined not by its morphological characteristics, but by its capability of producing a chemical substance which has a definite toxicological effect.

TUBERCULOSIS.—Whatever may be the ultimate verdict concerning the curative properties of Koch's tuberculin, its employment has made us familiar with the action of the chemical products of the bacillus tuberculosis on man. Unfortunately, Koch has given us but little information concerning the nature of his tuberculin, and the little which he has given us has been to some extent misleading. I would not imply that he has intentionally been misleading. Indeed, I believe that such was not his intention. He speaks of the agent as an extract of a pure culture of the bacillus tuberculosis with 50-per-cent. glycerine. Now, chemists who have been at work with bacterial poisons, distinguish between bacterial products and the contents of the bacterial cells. One would infer from Koch's statements that tuberculin is prepared by extracting the bacterial cells with 50-per-cent. glycerine, and that the bacterial products are not present. But, as has been shown by Hueppe and Scholl, the proteids of the cells of the bacillus tuberculosis cannot be extracted with 50-per-cent. glycerine. Moreover, the same investigators have prepared a fluid identical in physical properties, in chemical reactions, and in its effects on animals, with Koch's fluid, by each of the three following methods :

First. Cultures of the bacillus are filtered, sterilized by heat and concentrated.

Second. The supernatant, fluid portion of the culture is decanted from the mass of germs at the bottom of the flask, and then concentrated.

Third. The culture is freed from germs by filtration through a Chamberland filter and concentrated.

These fluids contain, *first,* the constituents of the nutritive medium which have not been altered by the growth of the germ, such as glycerine, albumins, albumoses and peptones ; *second,* the bacterial products, which may possibly belong to the ptomaines, the bacterial albumins or albumoses and bacterial ferments ; and, *third,* any constituents of dead, broken-down bacilli which may have passed into solution. To which of these constituents the action of the fluid is due has not been positively determined. However, from the similarity in the action of this fluid with that of the bacterial products of other germs, we seem justified in assuming that these constitute the active principle.

As early as 1888, Hammerschlag found a poisonous proteid among the products of the growth of this germ.

Recently Zuelzer has reported the isolation of a poisonous ptomaine from agar cultures of the bacillus tuberculosis. He says that the injection of 1 centigram or less of this substance subcutaneously in rabbits or guinea-pigs causes, after from three to five minutes, increased frequency of respiration (to 180 per minute ?) and an elevation of temperature of from 32.9° F. to 33.8° F. He also reports marked protrusive bulbi as a constant symptom ; the eyes become very bright and the pupils are dilated. From two to three centigrams suffice to kill rabbits, death occurring in from two to four days. The place of injection is reddened and hemorrhagic spots are formed in the mucous membrane of the stomach and small intestines ; in two instances from 15 to 20 cc. of clear fluid were found in the peritoneal cavity.—*American Medical Journal.*

TRANSLATIONS FROM THE GERMAN.

[BY H. W. LOEB, A. M., M. D., ST. LOUIS, MO.]

Transactions of the Pathological Anatomy Section of the Tenth International Congress at Berlin.

(*Continued from page* 433.)

From the Wiener Kliniche Wochenschrift, Vol. IV., Numbers 9 and 10

Max Wolff (Berlin) : ACTINOMYCOSIS. — The writer made report of a pure culture of actinomyces which he had obtained by an anaerobic process. Inoculation with these cultures (on rabbits) gave positive results which were demonstrated by the writer.

Gross (Krakau) : THE BACILLUS TYPHOSUS. — Report was made of the histological changes which result in the spleen at the point where the injection needle is inserted, for the purpose of the culture inoculation. These are doubtless to be ascribed to the influence of the bacillus typhosus itself.

GROSS (Krakau): ACTINOMYCOSIS. — He reported a case of actinomycosis of the sternum, with the pus of which he had made an inoculation into the anterior chamber of the eye with positive results. The eyes operated upon were demonstrated. The writer had observed the polymorphous character of the actinomyces which could present themselves in the form of single bacilli, while the well-known club shapes (Kolber) were absent.

In the discussion which ensued ZEIGLER (Freiburg) stated that by virtue of the experiments upon the antinomyces during the past year, and especially on account of his own observations, they might be considered as polymorphous bacteria. Further, he recalled that actinomycotic deposits are often found where the body is penetrated by splinters, particles of plants, etc., with the actinomyces adhering to them.

PONFICK (Breslau) replied that the absence of the *club-shapes* cannot overthrow the diagnosis of actinomycosis where the other circumstances agree. Since 1881 he has considered the antinomyces as polymorphous bacteria. An infection through the skin is possible. He also agreed as to the influence of particles of plants in the production of the disease, as before related, and he reported the case of a boy who had swallowed a bristle. Some months later an actinomycotic abscess formed upon his back, in which, upon opening, the bristle was found.

VON BARUSCH related a number of cases, and stated that, in accordance with his own experience, actinomycosis could be transmitted by kissing.

HANAU (Zurich) reported that he had inoculated the anterior chamber of the eye with actinomycosis, producing a positive result.

CHIARI (Prague): THE GENESIS OF ATHEROMATOUS CYSTS.—So frequently do atheromatous cysts of the skin and subcutaneous connective tissue occur, that there must be great diversity of opinion with reference to their genesis; most observers consider them as retentions from the sebaceous glands or hair follicles, while others grant a very narrow margin to the retention cysts as resulting from the physiological skin follicles and look upon almost all atheromatous cysts as dermoid cysts, *i. e.*, in effect an embryonal segmentation of the ectoderm. This is due to the fact that the points of differential diagnosis upon which the writers rely in the genetical division of the individual cysts are not demonstrable or not properly indicated.

Chiari made a systematic observation upon a great number of atheromatous cysts of the skin, and subcutaneous connective tissue in order to determine the genetical differential diagnosis of atheromatous cysts.

In this connection there was presented to the writer a most important case of multiple formation of atheromatous cysts of the skin and connective tissue, distributed all over the body of a man, æt. 74 years, who exhibited a remarkable collection of retention cysts of hair follicles and sebaceous glands, in all stages. Extended histological examination of paraffin sections of the cysts in this case showed that the retention cysts originated more frequently from the hair follicles than from the sebaceous glands; that there was always in the hair follicle only the portion of discharge corresponding to the sebaceous glands, and in the sebaceous gland the excretory duct was the seat of the cyst formation; that in the hair follicle cysts, the atrophic fundus of the hair follicle formed a typical appendix to the cyst; that all the retention cysts were lined with a wall of soft, smooth and flattened epidermis cells; that the hair follicle cysts which had attained a considerable size (the size of a nut) were pushed, in part, into the subcutaneous tissue, corresponding to the continuation of the subcutaneous connective tissue upon the hair follicle; that the excretory duct of the retention cysts was gradually pulled away and finally separated.

One group of these atheromatous cysts of the skin and subcutaneous connective tissue, observed by Chiari, agrees completely with the behavior of these undoubted retention cysts of the physiological skin follicles. So they were retention cysts, mainly originating from the hair follicles to which the atrophied fundus of the hair follicle generally hung. They did not present upon the inner surface of their soft wall any papillæ and empty flattened epidermic cells, and they exhibited the same details as the excretory duct.

The second group of atheromatous cysts observed on the contrary may, doubtless, be considered as dermoid cysts. They were often quite large, about the size of goose eggs, while the retention cysts, originating in the physiological skin follicles, were found only about the size of a nut. They (the dermoid) possessed a thicker wall which consisted of papillæ, a typical epidermis with basement, cylindrical cells, the rete and the stratum granulosum ; they were always found more deeply situated, at least in the subcutis. Between these and the more highly organized dermoid cysts, of which the wall consisted of the skin and all its appendages, a gradual transition was found. They occupied a fissural (*fissurale*) position, being situated, either within the reach, or in the neighborhood of a former embryonal line of closure, or corresponding to the place where segmentations or protuberances are formed at the time of embryonal development. Chiari thus signifies upon the evidence of his anatomical experience in atheromatous cysts of the skin and subcutaneous connective tissue, that one may accurately determine in every case the genetical differential diagnosis of the retention cysts originating in the physiological skin follicles or dermoid cysts, by means of microscopical examination, with the aid of a series of sections. He also indicates that it would on this account be judicious to drop the term atheromatous cysts altogether as it would be much more in accord with the origin of these tumors to call the first group hair follicle cysts or sebaceous cysts, and the other group dermoid cysts.

(*To be continued.*)

SCIENTIFIC GLEANINGS.

THE SMALLEST FRIENDS AND FOES OF MAN.

DR. W. ST.

Ueber Land und Meer, Stuttgart, June.

Dr. Koch's successful struggle with the tubercle bacillus, discovered by him eight years ago, has drawn the attention of the whole educated world to the various species of those minute simple organisms, which consist of one, or at most of only a few cells, and propagate by fission, *i. e.*, the parent cell, which is barely $\frac{1}{500}$ millimetre in diameter, divides into two daughter-cells, each of which grows and subdivides in the same manner, whence the name *schizomycetes.* These organisms being without chlorophyl — the green coloring matter essential to the proper independent development of all plants—become parasitic on dead or living organisms, and, preying and propagating on organic substances, in still or running waters, are taken into the digestive organs of man and beast, and thence find their way into the system. Some make their abode in the excrements of animals, and being reduced to dry dust are inhaled by us. The motes which we see in the sunbeam's track are on an average a thousand times as heavy as these minute organisms in their dry state.

The schizomycetes carry out the same destructive operations in the human or animal systems, as they do in plants, and, in so doing, generate the most fatal diseases.

The general form of schizomycetes guides to their division into four leading types:

First. Spherical-shaped, or *cocci,* which, according to size, are again subdivided into *micrococci* and *macrococci.*

Second. Rod-shaped, the shorter known as *bacteria,* the longer as *bacilli.*

Third. Thread-shaped, and

Fourth. Spiral-shaped.

In the course of their development schizomycetes vary in shape with varying conditions of sustenance, so that probably some of them which are known under one or more forms may sometimes assume other forms under which they are not recognized. Schizomycetes are for the most part provided with tentacles, which aid them in their movements to procure food.

Apart from the ordinary method of propagation by fission into two equal organisms, schizomycetes, like ordinary fungi, also throw off spores, that is to say, parts of themselves, which germinate and produce fresh fungi. Subject to extreme cold or heat they remain dormant, but awaken with full vigor on being subjected to favorable conditions. Schizomycetes are known to have lain dormant for thousands of years in dry air without losing their vitality. Death occurs only on complete exhaustion of the means of subsistence; but, although it is consequently very difficult for us to destroy them, they are frequently eradicated by other microscopic organisms. The struggle for existence is waged as fiercely in their ranks as among higher organisms. The appearance of a new species may be the signal for the disappearance of the hitherto dominant race.

Schizomycetes, finding their subsistence in foreign bodies, set up a process of decomposition in those bodies, and to their agency is due the conversion of manure and refuse into plant-food; meats that taste "high"; all food-substances that begin to "smell," are infested by them. When vegetables, or milk, or substances containing sugar turn sour, it is due to chemical changes set up by them. Fermentation is due to their activity and so is the phosphorescence on decomposing meat or fish. But in these processes of decomposition the schizomycetes for the most part work out their own destruction. They generate substances (*ptomaines*) which arrest their powers of decomposition and reproduction, and finally poison them. This fact forms the basis both of Pasteur's and of Koch's treatment.

These creatures subsist as well on animal as on vegetable substance, and in fact find the most favorable conditions in the human body. Here a single germ taken in with the food or with a breath may generate a hundred thousand in the course of seven or eight hours. They first fasten on the mucous membrane where, breeding rapidly, the work of destruction is soon in full swing. As soon as they have penetrated through the mucous membrane, they get taken up by the small blood vessels and circulate through the whole system.

One of the first discovered of these vegetable parasites was the *anthrax* fungus, found in the spleen and other internal organs of herbiverous animals, hares, rabbits, mice, birds of prey, geese, fowls, ducks, sparrows, etc. The slaughter of animals thus infected, the mere handling of their flesh, skin or hair may result in the communication to man of the poison.

Still more fatal are the species to which the several contagious diseases are attributable ; and the schizomycetes of the eye are scarcely less to be dreaded.

Finally, as possessing historic interest, we may mention the fungus which exists in the mouth of man and other mammalia, and causes the decay of the teeth. The self-same fungus has been found in the tartar on the teeth of Egyptian mummies. In fact there is evidence of the existence of schizomycetes in the carboniferous era, long before the appearance of man on earth.

Science has now entered on a crusade against these minute but formidable foes of humanity, but, to enable it to reach its desired goal, we must redouble our energies to prevent the spread of the fungi, by all due sanitary precautions.—*The Literary Digest.*

IMMUNITY FROM YELLOW FEVER.

Dr. Domingo Freire, who was recently sent by the Brazilian government to Berlin to study the Koch methods, described the bacteriological work done in connection with yellow fever before the *Verein fur innere Medicine* on March 9. Yellow fever is due to the cryptococcus xanthrogen, a well-known organism. It produces two pigments, a yellow and a black, of which the former is soluble, and gives a characteristic color to the skin ; the latter is not soluble, and is the cause of the black *vomitus.* The ptomaines contain a poison which acts on the medulla. In animals the disease can be produced by the ptomaines as well as by the cultures. Even by the third alternation of the culture immunity can be produced. After protective inoculation, symptoms occur which resemble the initial stage of yellow fever, but disappear in forty-eight hours. The results between 1883 and 1800 have been so favorable that the Brazilian government has recently founded an institute for the preventive inoculation of yellow fever, and authorized the expenditure of $5,000 for bacteriological apparatus.—*Boston Medical and Surgical Journal.*

*PATHOGENIC MICRO-ORGANISMS OF THE MOUTH.**

Dr. R. Kreibohm's investigation of the micro-organisms found in the mouth extended to *leptothrix buccalis* and some pathogenic bacteria. From microscopical examination, and from cultivation, the author came to the conclusion that leptothrix merely represents a peculiar phase of growth of different schizomycetes. Four forms were observed to develop leptothrix, two of which were bacilli, and two short bacteria.

Of the pathogenic microbes, the author was able to demonstrate four different species, of which three were not cultivatable on the usual nutritive media. All four kinds were fatal to animals, producing a septicæmia, and they were afterwards found in the blood in large quantities.

Positive results were obtained only from the tongue-fur of sick persons, and best from those in condition of high fever. To only one of these micro-organisms is a name given, *bacillus sputigenus crassus*, a short fat bacillus found in the sputum and tongue-fur of chronic bronchitis. These grew well on potato, agar and gelatin, and were easily stained by the customary methods. They were found to be very fatal to animals, producing gastroenteritis, pulmonary hemorrhage, and death in a few hours. Sterilized cultures had the same effect.

*NASAL BACTERIA IN HEALTH.**

Dr. J. Wright examined the nasal secretion of ten healthy persons in different ages for bacteria. The secretion had a neutral or slightly alkaline reaction. The germs were isolated by the plate method. There were found in six cases *staphylococcus pyogenes albus, aureus* and *citreus* ; in three, *micrococcus flavus desidens ;* in one, *bacterium tactis aerogenes ;* in one, *penicillium glaucum ;* in one, *micrococcus cereus flavus ;* in one, *micrococcus tetragonus ;* and in three, some undetermined species. The numerical preponderance of suppurative cocci agrees with the results of other authors.

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*Journal of the Royal Microscopical Society.

*MICROBIC PRODUCTS WHICH FAVOR THE DEVELOPMENT OF INFECTION.**

M. G. H. Roger finds that bacterial secreta have partly poisonous, partly vaccinative, properties. There are, therefore, among these some which favor the development of certain viruses. This latter phase has been observed by the author in the bacillus of symptomatic anthrax. This bacillus, which by itself is harmless to rabbits, speedily kills them if another microbe be injected along with it. This can be done with *staphylococcus pyogenes aureus, proteus vulgaris,* and especially with *bacillus prodigiosus.*

A similar result can be obtained from the anthrax bacillus itself. For if the serum from an anthrax tumor be deprived of its cell-elements by means of a porcelain filter, 4–5 ccm. per kilo. of live weight can be injected without harm, while 1–1.5 ccm. coupled with the anthrax bacillus quickly kills. The morbid predisposition induced by such a procedure is, however, of short duration, lasting not more than twenty-four hours, after which the animal again becomes refractory. Hence it would seem that a vaccinative effect is preceded by a period of diminished resistance to the virus.

Another observation showed that the anthrax bacillus did secrete products favoring its development ; for while the virus, if injected into the thigh, was powerless, the same virus was found to be fatal if injected into the anterior chamber of the eye at one and the same time. Hence the products of the latter injection must have arrested the immunity in the muscles, and accordingly it may be concluded that the resistance of animals to infectious diseases can be effected by harmless as well as by pathogenic bacteria.

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*Journal of the Royal Microscopical Society.

TYPHOID ORGANISMS.

At a meeting of the Section in Pathology of the Royal Academy of Medicine in Ireland, Dr. MacWeeney read a paper on this subject, and exhibited pure cultures on gelatin and agar-agar—the former obtained by von Esmarch's "roll-tube" method—from the spleen and enlarged mesenteric glands of a patient who had succumbed at an early stage of the fever, under the care of Dr. Nixon, in the Mater Misericordiæ Hospital, Dublin. He stated that it was his object not to produce a piece of special pleading on behalf of the bacillary etiology of typhoid, but simply to lay before the Academy as clearly and succinctly as might be the present state of modern science on the subject. In order to do so he had been obliged to wade through a chaotic mass of recent literature, chiefly in German. There were very few points in bacteriology about which there prevailed such direct difference of opinion among distinguished authorities as about certain problems in connection with the typhus bacillus.

Dr. MacWeeney said he proposed first to give a few historical details regarding the development of the bacillary doctrine for typhoid, and alluded to Eberth's researches, which (1880) were the first to throw any clear light on the subject. His methods and discoveries were described, and then Goffky's in 1884–86. The cultivational appearances first described by the latter observer were gone into and illustrated from the specimens laid before the Academy that evening. Dr. MacWeeney expressed his regret at not being able to produce a potato cultivation on that occasion. The one he had prepared had unfortunately become contaminated with mold, while the new ones were not sufficiently advanced. Owing to the biological questions concerning the bacillus, Dr. MacWeeney mentioned the various views of Goffky and Birch-Hirchfeld, who considered that it formed spores, while Buchner and Ali

Cohen were of opinion that the supposed spore-bearing condition depended upon involution-processes, or degenerative changes. The final point discussed was the pathogenity of the bacillus. Was it really the cause of typhoid ? As methods of research were gradually improved the bacillus was more and more constantly found forming familiar isolated colonies in mesenteric glands, spleen, liver, and sometimes in the kidneys of patients suffering from typhoid. Ali Cohen's exhaustive researches had shown that, while present in every case of the disease, it was invariably absent in all other infectious cases examined—*e. g.*, several of typhus. The real difficulty in making its cause and effect a matter of absolute certainty was the impossibility of inoculating animals with typhoid. They appeared to be insusceptible of acquiring the disease. Chantemesse and Widal asserted that they had communicated the disease to mice and rabbits ; their experiments were, however, invalidated by the totally opposite results arrived at by quite a series of observers (Goffky, Fraenkel and Simmonds, Beumer and Piper, Ali Cohen, *et al.*), who had found that the bacilli, whether inoculated subcutaneously or injected into the alimentary canal of lower animals, did not multiply but rapidly disappeared, and that the injurious effects observed were due not to an infective process, but to an intoxication with poisonous metabolic products (probably triamines) generated by the bacillus during its growth on artificial nutrient substrata. The results of Brieger's and De Blase's researches on these toxines were then given, and the paper concluded with a critical account of the various announcements lately made concerning the discovery of the bacillus in earth, drinking-water, river-water, milk, etc., and their bearing on such questions as the origin of epidemics, etc. In addition to the cultures (which had been made in the bacteriological laboratory at the Mater Misericordiæ Hospital), microscopic slides of the bacilli, both in pure cultivation and in tissue (mesenteric gland), were exhibited.—*New York Medical Journal.*

MISCELLANEOUS.

TUBERCULOSIS IN SWINE.

BY N. S. MAYO.

Some time ago Dr. Orr, V. S., left at my laboratory the testicle of a full-blooded Berkshire boar, with the remark that it looked tuberculous. Microscopic examination proved it to be a case of tubercular orchitis.

Tuberculosis among swine is quite rare. I find that among thirty thousand, nine hundred and twenty-two swine slaughtered at Augsburg only three were affected with tuberculosis. From the habits of the animal and the food, milk, raw meat, etc., we should expect more of it. Why don't we get it?—*Reported to Editor Bacteriological World by the Author.*

STERILIZATION OF MILK.

Petri and Maassen (Arbeiten aus dem K. Gesundsheitamte, *Deutsche Med. Zeitung,* No. 45) report observations made upon eighteen hundred bottles of sterilized milk, six hundred of these having been examined for bacteria. It is possible, as they found, to obtain by sterilization milk absolutely free from germ life. Several conditions, however, bear upon this point. Firstly, the composition of the milk at the time of sterilization, a permanent preparation being possible only when the milk is fresh and free from impurities; next, the time of sterilization; and, lastly, the storing of the already sterilized milk in cool places. By sterilizing we destroy the pathogenic organisms of anthrax, cholera, typhoid, tuberculosis, diphtheria, erysipelas, suppuration, as well as the bacteria of blue milk, etc. The sterilized milk has a certain cooked taste, easily distinguished from fresh milk, but by no means unpalatable, so that, as a rule, it is readily taken.

Hesse (*Zeitsch. f. Hygiene,* same reference) has arrived at the following conclusions as a result of his work upon the question of sterilization.

First. Milk suitable for sterilization can only be obtained from healthy, dry fed and carefully tended cows.

Second. All possible contamination of milk up to the time it is placed in the sterilizer is to be most carefully guarded against.

Third. If possible, sterilization should be effected immediately after milking. If this cannot be done, the milk is to be at once cooled and maintained at a low temperature. Even then, not more than a few hours should elapse before sterilization.

Fourth. To avoid the cracking of bottles in the sterilizer, the latter, filled to about four-fifths of their capacity, should be introduced into the sterilizer cold, and the temperature gradually brought up to the boiling point ; or, what is preferable, first warmed with their contents and then subjected to the proper heat.

Fifth. The milk is to be brought to the boiling point, the temperature being indicated by a thermometer penetrating into the interior of the apparatus. Once this degree is reached, the process is to be continued for an hour and three-quarters. Then the milk is truly sterilized. In bottles made of green or brown glass it will keep indefinitely. White glass bottles should be protected from the direct rays of light.

Sixth. Every bottle should be tested, immediately before using, with reference to taste and odor.

It is believed safer for each family to sterilize its own supply for daily or weekly consumption, rather than to depend upon articles of commerce, which, being prepared in much larger quantities, are thereby also more liable to contamination or subsequent accidents.

Guerin has recently suggested, as a substitute for sterilization, freezing of the milk, in elastic reservoirs, so that it may be carried in blocks, like ice. Such milk, upon thawing, has the taste of fresh milk, can be churned, or boiled just as fresh milk can. It can be preserved for two or three weeks, if kept at a suitable temperature. The preparation, however, always requires the use of an ice machine and suitable non-conducting receptacles for milk, and is hardly as practicable as sterilization.—*Cincinnati Lancet-Clinic.*

THE INFLUENCE OF GASTRIC JUICE ON MICRO-ORGANISMS.

Kianovsky (*Vratch,* 1890) has published an extensive work on this subject, in which he comes to the following conclusions:

The healthy stomach, when empty, always contains a large number of different microbes. The number found in the contents of the stomach an hour after a meal is in direct proportion to the number contained in the food when it was eaten. Gastric juice possesses germicidal properties, principally on account of the free hydrochloric acid which it contains. Gastric juice of normal acidity, and with a certain amount of free hydrochloric acid, kills a number of the micro-organisms in ingested food, the number killed being in direct proportion to the length of time that the food is in the stomach. In persons with diminished acidity of the gastric juice the number of microbes increases, and these persons are more liable to systemic infection from the alimentary tract.

The author was unable to find any evidence that the presence of micro-organisms was in any way an aid to digestion.—*Boston Medical and Surgical Journal.*

STERILIZATION OF RUBBER CATHETERS.

Dr. Alapy describes (*Annal des Malad. des Organ. Genito-urin.*) a new method of effecting the sterilization of these instruments, which possesses, he asserts, the merit of being very effective, easy to carry out, and harmless to the instruments. After drawing attention to the effect of various antiseptics, such as carbolic acid, sublimate, etc., and heat as ordinarily applied, he goes on to describe his own plan, which practically consists in wrapping up the instruments, not more than three or four in a packet, in ordinary blotting paper, the ends of which are just twisted up. These packets are then placed in glass tubes, the mouths of which are sealed with a plug of cotton wool. The glass tubes are exposed for half an hour to ordinary steam, that is, to a temperature of 212° F. The packets of blotting paper are then removed, and kept in a drawer or box till they are required for use. The catheters remain sterilized for any length of time provided the paper is not untwisted.—*Druggists' Circular.*

ANTHRAX.

Dr. Czarkowski describes a severe case of facial authrax in a woman of forty, where he resorted to hypodermic injections of a two-per-cent carbolic acid-solution into the swollen and brawny tissue (one syringeful, three to four times daily). A speedy recovery ensued. In the course of the last nine years, thirteen cases of authrax were treated by the author after this simple method, every one of the patients making good recovery. In every case deep incisions into the pustule were also made, and the wounds thoroughly cauterized with pure carbolic acid ; besides, port wine was administered internally.

Dr. Potiejenko has tried the injections of a ten-per-cent solution of carbolic acid in four exceedingly severe cases of authrax, and has obtained a complete cure in all four cases. Three or four syringefuls of the solution were injected into the swelling and its neighborhood once daily, the part being kept covered in the intervals with compresses soaked in a five-per-cent solution of the same acid. No other treatment was employed.

Dr. Arnoldow eulogizes the treatment of anthrax by injections of corrosive sublimate dissolved in a five-per-cent carbolic acid solution (two grains to the ounce).—*Medical Brief.*

TEST FOR DRINKING WATER.

Professor Angell, of Michigan University, gives the following simple test for drinking water which may be of use to the householder, whether in town or country : "Dissolve half a teaspoonful of the purest white sugar in a pint bottle quite full of the water to be tested, and stop the bottle carefully ; then expose it to daylight and to a temperature up to 70° F." If examined after a day or two, when held against something black, any organic matter present in the water will appear in the form of floating specks.

TECHNIQUE.

Ehrlich's test in typhoid fever.—This test, which has been known for a number of years, has till recently been regarded by many rather as a medical curiosity than as of diagnostic value. Dr. C. E. Simon, of the Johns Hopkins Hospital, has recently shown that, by carefully following the precise directions for its use, valuable information may be derived. The test consists of two solutions. *First.* A saturated solution of sulphanilic acid in 5-per-cent. hydrochloric acid, and, *second,* a 5-per-cent. solution of sodium nitrate. These are to be mixed, just before use, in the proportion of 40 cc. of first to 1 cc. of second. If this mixture be added to urine from a case of typhoid fever, the further addition of ammonia will produce a play of colors varying from an eosine rose to a deep garnet red. The best method of applying the test is to take a few centimetres of urine in a test-tube, adding an equal quantity of the sulphanilic acid mixture and shaking thoroughly ; 1 cc. of ammonia is then run carefully down the side of the tube. At the junction of the two liquids there will be observed a ring of the characteristic color, which is produced in scarcely any other disease than typhoid fever. Dr. Simon's conclusions may be thus summarized : *First.* The reaction may be obtained in typhoid fever from the fifth to the twenty-second day of the disease. *Second.* Its absence from the fifth to the ninth day indicates a very mild attack, save in children, although this rule is not an absolute one. *Third.* As it occurs previous to the appearance of the rash, it is a very useful aid in the diagnosis of typhoid fever.—*Therapeutic Gazette.*

DEMONSTRATING TUBERCLE BACILLI.*—Dr. Bliesener recommends the following method as being very expeditious:—The cover-glass, having been dried in the air and passed thrice through a flame, is placed with the sputum layer uppermost on a metal plate about 5 to 6 cm. square fixed to a stand so as to keep it horizontal. Five or six drops of carbolic fuchsin are then dropped on with a pipette and the metal plate warmed until the fluid begins to evaporate. The flame is then removed, and then the cover-glass, after remaining on the plate for about a minute, is washed with water previous to its being dropped on the acid contrast fluid (methylen-blue 1.5, H_2O 100, H_2SO_4 25). In about fifty seconds it is removed, washed in water, and examined.

The foregoing staining procedure, if combined with Biedert's method of examining sputum, is said by the author to be very satisfactory. Biedert's method consists in boiling the sputa with water to which some drops of caustic soda have been added.

INFLUENCE OF THE KIND OF NUTRIMENT OF A BACILLUS ON THE DIASTASE SECRETED BY IT.*—M. W. Vignal has found, from a series of experiments which he has made from some bouillon cultivations of *bacillus mesentericus vulgatus,* that up to a certain degree the nutrient media exert a definite influence on the quantity of the excretory products secreted by this bacillus. This influence made itself appreciable to a slight degree on the addition of sugar or starchy material, and to a significant extent on the addition of casein. The excretory products always quickly disappeared from the cultivation fluids.

COUNTING TUBERCLE BACILLI.—In the last issue of the *Bulletin of Johns Hopkins Hospital,* G. H. F. Nuttall, M. D., gives an improved method for "the estimation of the actual number of tubercle bacilli in tuberculous sputum." The plan is illustrated and carefully worked out; the author maintaining: "With such organisms as the tubercle bacillus, this method will enable the experimenter to determine the number he is inoculating into an animal in way that has not been possible hitherto. Inoculations under such conditions will clearly show the difference in degree of virulence possessed by various organisms. It will clear up any relation which may exist between the number of tubercle bacilli in sputum and the progress of the disease, and bring us a step nearer to solving the problem of the significance of involution and degeneration forms of bacteria."—*Journal American Medical Association.*

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*The Journal of Royal Microscopical Society.

READING NOTICE.

THE AMERICAN SOCIETY OF MICROSCOPISTS.

This Association, now in the thirteenth year of its existence, will hold its fourteenth annual meeting in Washington, D. C., August 10, and continue in session five days. Its roll of active members contains about three hundred and fifty names, embracing very nearly every person in the United States who is at all prominent as a microscopist. Its membership consists of two distinct classes, viz., professional men and students of the natural sciences, who use the microscope in their daily avocations as an instrument of research, diagnosis or precision ; and amateurs, or those who find pleasure and profit in the revelations of the instrument. Many of the latter class, from having early chosen special lines of study and investigation, have acquired high reputations in their respective departments of microscopical research. In its earlier years this class predominated in the membership of the society, but at present the professional element is largely in excess.

The qualifications for membership are very simple. The applicant must be a respectable person socially, and interested in the use of the microscope.

We invite and urge upon all persons, professional or amateur, interested in microscopy and not already on the rolls, to send in their applications for membership to the Secretary, Dr. W. H. Seaman, No. 1427 Eleventh street, Washington, D. C. The application should be accompanied by $3, which is the initiation fee and one year's dues. As it is more than probable that the initiation fee will be increased in the near future, it will be to the advantage of all who contemplate membership to send in their applications before the next meeting.

Any further information concerning the Society or the approaching meeting may be obtained by addressing any of the undersigned.

Frank L. James, President, box 568, St. Louis.

W. H. Seaman, Secretary, 1424 Eleventh st., Washington, D. C.

C. C. Mellor, Treasurer, No. 77 Fifth Avenue, Pittsburg, Pa.

REMEDIES AND CLINICAL NOTES.

For face and body eruptions (which, by the way, are always complicated by bacteria if not actually produced by them) the following is exceedingly efficacious:

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LITERATURE.

LIPPINCOTT'S MONTHLY MAGAZINE.

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A Rose of a Hundred Leaves	Amelia E. Barr.
Physical Culture	Edwin Checkley.
A Surprise to Mr. Thompson Byers	Richard Malcolm Johnston.
Rosebud and Rose	Henry Collins.
The Future of Cuba	Frank A. Burr.
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Sunshine and Rain	Charles Henry Lüders.
The Vengeance of Padre Arroyo	Gertrude Franklin Atherton
Talleyrand and Posterity	C. R. Corson.
Some American Changes	James W. Gerard.
Overthrown	Charlotte Mellen Packard.
Death-Damp	Felix L. Oswald.
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Some New Books	H. C. Walsh.
With the Wits. (Illustrated by leading artists.)	

CONTENTS FOR AUGUST.

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At a Poet's Funeral	Anne Reeve Aldrich.
My Adventure with Edgar Allan Poe	Julian Hawthorne.
Fancy	Daniel L. Dawson.
A Culprit	Charles Henry Lüders.
A Plea for Patriotism	Mary Elizabeth Blake.
Re-roasted Chestnuts	George Grantham Bain.
The Slav and The Indian Empire	Clarence Bloomfield Moore.
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THE POPULAR SCIENCE MONTHLY.

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The Development of American Industries Since Columbus. VII. The Evolution of the Woolen Manufacture. (Concluded.) (Illustrated.)................S. N. Dexter North.
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The Practical Outcome of Science........W. H. Smith, M. D., Ph. D.
Dress and Adornment. I. Deformations (Illustrated.)..........................Prof. Frederick Starr.
Prof. Huxley and the Swine-Miracle......W. E. Gladstone.
Illustrations of Mr. Gladstone's Controversial Method ....Prof. T. H. Huxley.
Head-Flattening as Seen Among the Navajo Indians. (Illustrated.)..........Dr. R. W. Shufeldt.
The Relations of Abstract Research to Practical Invention.......................F. W. Clarke.
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Sketch of Friedrich W. A. Argelander. (With Portrait.)
Editor's Table: Science and Wealth.
Literary Notices.
Popular Miscellany.
Notes.

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EDITORIAL.

TROUBLES OF THE ALIMENTARY CANAL.

Under this heading, an editorial signed T. E. P. appears in the *Western Medical and Surgical Reporter* of July offered as "suggestions to the physicians," and which it is implied is "based on rational conclusions." It is strange that the learned "Professor" should have written so irrationally from "rational conclusions." But, then, we of the common class of physicians should perhaps feel content and gratified at being offered any suggestion, be it ever so slight or irrational in appearance, when coming from the pen of a leader. And we should not think it strange, either, if, from such profound sources of learning, we are confronted with doctrinal teachings based on *new* physiological laws, and on a peculiar pathology possibly resulting therefrom. We have a faint recollection of hearing the same astute teacher of medicine expound the doctrine of "cheesy degeneration of the brain," and we are prepared for almost anything.

He claimed that in a patient so affected, in which he made a *post-mortem* examination "*after death, all the mental faculties,* which were above the average, had been retained during a long illness." It was admitted then and there, that this "cheese" was even stronger than the live specimen nailed to the table in the play entitled "A Pair of Kids," by a hungry man who feared it might elope.

To the Missouri Medical Association this was a bit of news which provoked deadly silence, not one daring to discuss the wonderful "cheese" for fear of showing his ignorance of physiology and pathology.

Now comes other astounding revelations. As we are far away, we dare write and discuss them.

At the outset the law in the matter is laid down in the following unmistakable words:

"Most bowel troubles come from two great causes: *First.* Derangement of the liver, interfering with the partial circulation, thereby bringing on general congestion of the mucous membrane of the stomach and intestinal canal, which congestion tries to relieve itself in an active diarrhea. *Second.* By the introduction into the stomach of acrid and undigestible food or food beginning to take on putrefaction. *Third.* These two causes may combine to bring about the disastrous results."

There is a grain of truth in the first-named cause, but we suspect that the author has special conceptions of the laws of physiology or else the language would give us a clearer meaning of the points he intended to elucidate. All that is said in the second is true, but constitutes only a very slight portion of the truth. The third is misleading; it does not require the two causes first named to bring about disastrous results; deadly diarrhea and dysentery may and do appear quite independent of either cause.

Further on the writer says, after dwelling on the furred tongue, the inactivity of the liver, etc., that "the principel" cause bringing on this state of affairs is "malaria," which takes often the "name of biliousness." Now, Doctor, what is malaria and what is biliousness? These two terms are very convenient to cover our ignorance of the facts, the truth. This furred tongue occurs where there never is any so-called malarial trouble.

Again the writer says: "In bloody dysentery we find the seat of the trouble *entirely** in the liver, with local manifestations in the mucous membrane of the rectum." If this is true, then the misnamed "local manifestation" must be the worse part of the disease or else we must naturally infer that the blood passed from the bowels comes from the "seat of the trouble," a hemorrhage of the liver, in fact. Would it not be simpler and truer to say, "bloody diarrhea so-called is due to the inflammation of the large intestines,"† and then explain the cause and pathology of the affection, which could be done *without* bringing in the liver as a necessary factor?

But these are only selected points of the teachings in the remarkable editorial; I mention them as a prelude to the comedy. Here is what the teacher says further after speaking, very wisely for once, of the dangers of eating unripe fruit, etc.: "There is one point in this connection we desire to call *special** attention to, viz., the *cause** of putrefaction is 'ptomaines,' the *bacteria** found in all decaying bodies whether vegetable or animal * * *." And again he recommends further calomel "to destroy the exciting germs called *ptomaines*."* We are almost undignified enough at this ridiculous statement to say that any good medical student in a sound medical college knows better the first day after his entrance. Indeed, the daily newspapers give us more truth.

A ptomaine is a chemical substance, a basic compound resulting from putrefaction. It resembles a vegetable alkaloid and cannot be called a germ with any more truth than one can call atropine the belladonna plant.

Oh, ye educators in the field of medicine, how many fallacies you have taught and how many inflictions you bring on the world, your patients, and the patients of your pupils by your sciolistic methods!

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* Italics are ours.—ED.]

† I do not mean to imply that this is the only cause of bloody bowel discharges.

If laws are passed to regulate the duration of medical courses and medical colleges, why not pass one to regulate the teachers and secure the public against dangerous fallacies?

DOES THE GERM PRODUCE THE DISEASE OR DOES THE DISEASE PRODUCE THE GERM?

This remarkable question in this century, in the year 1891, is rather astounding, and one is tempted to at once conclude that the propounder is joking. Yet, this is the question asked seriously by Dr. W. J. Atkinson of Clarksburg, Missouri, in the August number of the *American Medical Journal* of St. Louis, the organ of the St. Louis Eclectic School.

The BACTERIOLOGICAL WORLD has no creed but science, no aim but truth; hence, we study every kind of medical literature and feel justified in defending the truth wherever fallacy appears concerning microbes and kindred subjects.

The peculiar philosophy and illogical statements made in the print under the above question, appearing with the caption of "disease germs" deserve our attention a moment.

It is not our purpose to deal with the erratic not to say foolish attempts to compare "ideas," "thought" and "disease" germs in their adaptation to "soil," nor is it our province to discuss the notions expressed as to what is health, what is life, what is disease. All that is said on these topics appear to be purely the expression of guess work, or to be notional ideas resulting from a lack of knowledge of the physiological laws underlying all living things, plants or animals.

The only point I wish to touch upon is in the following statement: "Disease germs, then, consist in the degradation or alteration of the primary elements in the blood into other living matter which is capable of independent existence with prodigious power of reproduction if vital force is low * * * ." Can a scientific mind, a man with sound judgment, one who has studied the laws of nature, the physiology of plants and animals, small and large, conceive of a more inconsistent, visionary, sciolistic absurdity? Indeed, are not such statements an insult to common sense? Why not go back to Aristotle's time and say with him that eels are formed out of fermenting slime in the rivers, and that caterpillars are formed by putrefaction of the earth? Or why not say with the men of his time that "maggots" are generated by decomposing meat? Why this is the fallacy of spontaneous generation resuscitated in the face of truth and light!

How can men seek to impress such flighty notions when we have solid facts concerning the life, structure of all beings and the reproduction of species? There is but one conclusion that logic can reach in comtemplating such statements and it is: that knowledge does not lie at the bottom of such writings; it is the worst form of sciolism so common among certain medical classes. Just think of a man whose body gradually generates germs of disease! Did it ever occur to Dr. Atkinson that the so-called disease germs are vegetables? How can one conceive of the generation of a plant by an animal? Just think of "degraded elements of the blood of a man" becoming by transition, without actual decompositon as is implied by fermentation, "other living matter," minute plants, microscopic trees say, capable of "independent existence and reproducing themselves prodigiously if *vital force is low!*"

What magnificent philosophy! How wise and knowing these physicians! Why, doctor, a germ of disease is simply this: *a microscopic parasite.*

Ten thousand books of etherial theories and poetical visions cannot alter this simple fact. Common sense is a better guide for the students, the physicians, the masses, than the teachings of sciolism.

NOTICE TO SUBSCRIBERS, ADVERTISERS AND OTHERS.

Beginning with the September number the BACTERIOLOGICAL WORLD will be published at Battle Creek, Michigan, where the Editor will be located as Director of the new Laboratory of Hygiene of the Battle Creek Sanitarium.

This most worthy, philanthropic, scientific, medical institution has taken a step in advance of any Sanitarium in the world, in building laboratories for the purpose of investigations in the field of hygiene for the benefit of the nations, without any hope of financial returns.

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Because of absence from his post on account of illness in his family, the Editor has not been able to give to the magazine, in proper time, the close attention it needed. Henceforth, we shall be in a position to push the work more and cause the appearance of the BACTERIOLOGICAL WORLD regularly. We hope to satisfy the minds of the most critical scientists, medical men and others interested.

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Owing to the work of moving our office and editorial work to Michigan we are compelled to leave our regular lesson in Bacteriology for the September number.

ORIGINAL ARTICLES.

AN EXPLANATION OF THE PHENOMENA OF IMMUNITY AND CONTAGION, BASED UPON THE ACTION OF PHYSICAL AND BIOLOGICAL LAWS.

BY J. W. M'LAUGHLIN, M. D., AUSTIN.

Read before the Texas S. M. A., 1891.

Contagion consists in the transmission of communicable diseases from one individual to another through the agencies of contagia, the efficient causes of all contagious diseases; these contagia may be communicated by contact, through the atmosphere, or from infected articles, fomites.

Immunity signifies that condition of the body which opposes the development of contagious processes. The principles involved in the causation of contagion and immunity, therefore, lie at the very foundation of all knowledge of those laws which control infectious diseases.

The importance and wide application of these principles, and the successful efforts which nature has made in concealing them from man's knowledge, have stimulated him to great and laborious investigations, and have resulted in the production of many ingenious theories.

This subject has occupied a large share of my attention for many years. From observing nature's methods in other departments of science—how, through the action of physical laws, physical results are obtained—the conviction grew upon me that physical law would furnish the key that would unlock our problem. The subject was so complex, the observed phenomena were apparently so diverse and even contradictory, that a long time elapsed before I was able to report any progress. In 1887, I published the first results which I obtained by this method.* Notwithstanding the subject was still very hazy at that time, I could see how the laws of wave motion, when applied to the motion of organic molecules, would explain some of the phenomena of contagion, but the complete elucidation of the subject had not yet dawned upon me. Francis Galton says: "Few intellectual pleasures are more keen than those enjoyed by a person who, while he is occupied in some special inquiry, suddenly perceives that it admits of a wide generalization, and that his results hold good in previously unsuspected directions." While thinking over the phenomena of contagion and immunity, and the laws of wave motion, the beautiful law of interference occurred to me, when it flashed over me that the application of this law to molecular wave motion completed the chain of evidence. I felt very much as I imagine did Archimedes when he sprang from his bath and ran naked, shouting "Eureka," through the streets of Syracuse.

Time will not allow an attempt to kaleidoscope the history and varied opinions regarding contagion; suffice it that in this, as in the evolution of other questions of science, the theories offered from time to time were based upon such information of the subject as was then known, and all possess some truth.

In the light of our present knowledge it can be safely asserted that contagium is a particulate substance; that it is capable, when suitably environed, of increasing itself indefinitely by multiplication of its particles ; that in this increase it produces only its own kind, and does this as unerringly as do animal or vegetable species in their increase by generation. Thus a very small portion of small-pox virus or contagium, if inoculated under the skin of a susceptible person, will multiply and increase itself in the blood of this person, and pustules will form upon his body which will contain the same character of contagious substance, possessing the same distinctive properties, as that used in inoculation.

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*Etiology of Acute Infectious Diseases, Daniel's Texas Medical Journal.

Or, a person with an infectious fever may infect a hundred or more persons with the same disease, transmitting to each one the amount and kind of contagium that he himself received at the time of his infection.

There is no known substance, neither a solid, a liquid, nor a gas, save and except a living organism, which is capable of increasing and multiplying its own kind in the manner thus described.

The striking similarity which is seen between fermentation and contagion has led many observers to believe that the latter, like the former process, is caused by microscopic organisms. As there are many kinds of fermentation, each kind resulting from the action of specific organisms—for example, alcoholic fermentation is caused by the yeast plant ; acetic fermentation by the micrococcus aceti ; butyric fermentation by the bacillus amylobacter, etc.—so it is claimed that each specific infection has its specific bacterium or bacteria. I do not think that it can be claimed that only one species or variety of bacteria will produce a specific infection, for example, a specific infectious fever. It is well known that fermentation—alcoholic, acetic or butyric—may result from the action of more than one kind of ferment or bacteria. Hence, if the analogy between fermentation and contagion is sound, there are grounds for believing that more than one kind of bacterium may cause a specific infection ; for example, diphtheria, cholera and other infections may each be caused by one or more kinds of bacteria.

A bacterium is a one-celled vegetable micro-organism or plant, which is so very small that the highest powers of the microscope are often needed to render it visible. It is composed of a complex substance called protoplasm, which Huxley has named "the physical basis of life." The cells have no visible nucleus, and may or may not have a limiting cell covering.*

All classifications of bacteria are provisional, yet it is convenient to arrange them according to their growth and group-forms as they are at present understood. When round cells group themselves singly or in masses, which are more or less characteristic, they are termed micrococci. Those growth-forms, characterized by the cells being joined together end to end to form rods or spirals, are called bacilli or spirilla. When the vegetative cells or spores of future bacteria grow within the bodies of bacteria, they are classed as endosporous varieties. On the contrary, when the spores are found differently, that is, outside the bacteria, they are said to belong to the arthrosporous variety.

Those bacteria which find in other organisms alone conditions suitable for their growth and development are called parasitic bacteria, while those forms which live upon dead substances are called saprophytes. In whatever form or shape the bacteria are found, whether as cocci, rods or spirals, they are always one-celled organisms, and, however much these cells may resemble each other in their appearances, these resemblances cease to exist when we compare the character of work which these cells are capable of doing. Vegetable and animal cells differ in this respect among themselves as greatly as do the animal or vegetable substances composed of such cells. We are familiar with the various kinds of tissue cells of which the human body is composed; we know that some of them are glandular and are connected with the secretion of bile, gastric juice, etc.; or in the separation from the blood of certain products of tissue metamorphosis; that others enter into the formation of the nervous system, and are connected with volition and motion; others form bone or cartilage or muscle, etc. Now, the single-celled vegetable organisms known as bacteria differ as greatly among themselves in the character of work which they perform as to do the tissue cells of the human body. A few illustrations of this fact will not be amiss. We will briefly refer to the kind of work done by the micrococcus ureæ, the nitrifying bacteria, the bacteria of the mother of vinegar, the bacteria of lactic acid fermentation, and the bacteria of the decomposition of proteids.

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* Bacteriologists universally teach that every bacteria is composed of a membrane (cell covering) and a content (protoplasm).—EDITOR.]

The micrococcus ureæ consists of round cells, microscopic in size, which may be formed singly or joined end to end like a string of beads; this organism converts urea into carbonate of ammonia; it is capable of doing this not only in the urine, but a pure culture of this organism will do the work just as readily if added to a solution of urea.

Micrococcus nitrificans consists also of small round cells. This organism or microbe converts the compounds of ammonia which are found in the soil, or added to it for fertilizing purposes, into saltpetre, which is appropriated by growing vegetation. It might appropriately be called the granger microbe, for through its influence the growing crops are enabled to utilize the ammonia compounds of the soil, which would be useless without this agency. A pure culture of this microbe, if added to an artificial nutrient solution containing compounds of ammonia, does its work as effectively as though it were at home in its native soil.

Micrococcus aceti, another small round cell, is the agent by which alcohol is converted into acetic acid; the various methods used in the arts for making of vinegar are based upon the power of this microbe of converting watery solutions of alcohol into acetic acid.

Micrococcus lacticus* occurs in the form of minute cylindrical cells, and is the microbe chiefly concerned in the souring of milk, by converting the sugar it contains into lactic acid.

Bacillus amylobacter† is the microbe of butyric-acid fermentation. It vegetates in the form of slender cylindrical rods, and is one of the most widely diffused and important and varied in its powers of decomposition. In addition to the important part it plays in the manufacture of cheese, it is a specially active agent in destroying the cellulose of cell membranes in the decomposition of decaying plants. In the process of rotting hemp, flax and other textile plants, in order to obtain the fibres, this microbe plays the all-important part. Van Tiegham attributes to this organism an important part in the nutrition of ruminant animals. He claims that it vegetates in their stomachs and splits up the cellulose of their food into soluble products. For illustration of the bacterial decomposition of the proteids we will refer to the bacterium termo (the drum-stick bacillus of putrefaction). Its uses in the economy of nature—for example, in disposing of dead animals—are sufficiently apparent to require no specification. Were it not for this microbe, it would be a serious matter to know how to dispose of dead bodies. If it was necessary many other examples of friendly microbes, those necessary to man's comfort or his safety, could be cited to illustrate the power which these organisms have of decomposing or splitting up many substances. It will be seen, however, from what has already been said, that there is a striking difference among these lowly cells as to the character of fermentation or kind of work which they are capable of doing; thus one variety causes acetic, another butyric, and yet another lactic acid fermentation.

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* M. Acidi Lactici.—Ed.]

† B. Butyricus.—Ed.]

One of the objects of this paper will be to establish as a fact that the principles involved in fermentation are the same, regardless of the exciting cause, and that the products of fermentation will largely depend on the molecular structure of the exciting ferment. Before entering upon this subject I shall invite your attention to certain phenomena attending fermentation, and for illustration will describe that form which results in the production of alcohol. It is well known that vinous fermentation has for its ferment, or exciting cause, a small-celled vegetable organism generally known as the yeast fungus, and that brewers' yeast is entirely composed of these cells. When, under suitable conditions, yeast is added to a solution of malt, called "wort," fermentation will ensue, and alcohol will be the principal resulting product. One of the substances which the "wort" contains is sugar, and it is this sugar which the yeast cells decompose and convert—at least ninety-five per cent. of it—into alcohol. The yeast cells, like other organisms, multiply themselves by the generative act and thus increase in amount, so that the amount of yeast is a thousand-fold more at the end of fermentation than it was at the beginning. Alcohol, the principal product of vinous fermentation, is poisonous to the yeast-cells, and when, during the process of fermentation, a certain per cent. of alcohol is formed, fermentation at once ceases, and cannot be re-established until the alcohol, or a considerable portion of it, is removed. That fermentation occurs only in contact with the yeast cells, and does not result from a hypothetical enzyme secreted by them, is established in the following way: Divide the fermenting vat or vessel into two parts by a membranous diaphragm, so that no substance can pass from side to side except through the interstices of the membrane. Put your solution of malt equally into both sides, but put the yeast plants in one side only. Now, all soluble enzymes, or other soluble substances contained in the malt solution, can readily pass through the diaphragm by osmosis, from one side to the other, forward and backward, but the insoluble yeast plants are confined strictly to the side into which they were placed. Under these circumstances fermentation has been found to occur only in that side of the vessel in which the yeast cells have been placed. An interesting and, for our purpose, an important fact connected with this subject has been established by Oscar Brefeld, who, by a peculiar artifice, has so modified the yeast cells in their structure that they can be made to grow and multiply in the solution of malt without producing a particle of alcohol;* the bearing of this fact upon one of the phenomena of contagion will become apparent further along. We are now prepared to point out the striking similarity in phenomena of fermentation, as set forth, and the phenomena of contagion.

Both are caused by one-celled vegetable organisms; these cells in each case are microscopic in size, and can be conveyed from place to place in various ways that will readily suggest themselves, and, therefore, require no special mention.

The cells of bacteria, like the cells of the yeast plant, excite fermentation and decomposition when they are suitably environed. In the same manner that yeast cells decompose sugar into alcohol, the cells of the micrococcus ureæ convert urea into carbonate of ammonia, the cells of the micrococcus nitrificans convert ammonia compounds into saltpetre, the cells of micrococcus lacticus convert sugar into lactic acid, and pathogenic bacteria cells convert certain albuminoid molecules of the blood or tissues, of man and animals, into poisonous substances, ptomaines or toxines.

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*Fermentation, Encyclopædia Britannica.

And, again, as alcohol is poisonous to the yeast cells and will arrest the fermentation which they excite, and by which it was produced, so ptomaines and toxines, the product of infection created by the cells of pathogenic bacteria, poison the bacteria which caused their existence, and arrest the fermentation or infection which gave them life.

And, finally: As the yeast cells can be so modified in their molecular structure that they can be caused to grow and multiply in malt solution without producing alcohol, in a similar manner the cells of some pathogenic bacteria can be so modified by "attenuation," in various ways, that they are not only made harmless to man, but become a vaccine by which protection from the virulent microbes may be secured.

In all the examples of fermentation which have been cited, or, as a matter of fact, in all fermentations or infections, the products resulting from these processes, whether it be carbonate of ammonia, acetic acid, saltpetre, lactic acid, alcohol or ptomaines or toxines, are invariably caused by cells decomposing or splitting up certain substances contained in the nutritive solution.

It behooves us, then, to inquire into the mechanism of this wonderful little cell, and to ascertain how, or by what method, it is capable of doing this work. At the outset, let me say that there are many things pertaining to the life history, physical structure, and mechanism of the cell which are not understood; in fact, our knowledge of cell life and structure, beyond what is revealed by the microscope and chemistry, is very meager. This subject offers an immense field for speculation and theory, which has not lacked cultivation. When there are not sufficient facts with which to build a theory, speculation becomes necessary to complete the structure, and often answers an excellent purpose, provided it is constantly guided and limited by established laws of chemical and physical science, and provided, also, that the theory thus constructed is found to be competent to explain the phenomena connected with, and belonging to, the subject Now, the theory of cell action which I offer, although largely speculative, complies with the conditions just stated. For a better understanding of this theory I will premise its discussion by the following statement of physical laws :

An elementary substance is the simplest known condition of matter. An atom is the ultimate part of such substance.

A compound substance is composed of dissimilar atoms. A molecule is the smallest division of a compound substance which has the properties of the substance.

Each and every atom has a natural period of vibration from which it cannot be separated.

Force, the efficient cause of all physical phenomena, is motion, atoms, molecules or of mass. Attraction, light, heat, and electricity are manifestations, or modes, of one and the same force ; they are co-ordinate and subject to the laws of transmutation of energy.

As atoms have their equivalents of motion—for example, their laws of attraction, repulsion and combination—which are inseparable from them, it follows that, when atoms combine to form complex substances, each one carries into the combination its equivalent of force or motion ; this may be modified by the motion of associate atoms, but it's never lost, and when the dissolution of the compound takes place, the departing atoms carry with them the same amount and kind of motion which they had originally.

All atoms, whether combined or uncombined, are in constant motion.

The atomic motions of each element observe definite periods of time in their recurrence.

Atoms of different elements observe different periods of time in their movements.

These prefatory remarks prepare us to recognize our little microscopic cell as a complex molecular substance possessing energy, and that this energy or power to do work is the result, and represents the total motions, of its contained molecules. If it was possible to magnify one of these cells to a size sufficient to enable us to see its atoms and molecules, what a wonderful sight would be offered us! How astonishing it would be to witness the arrangement of its millions of molecules, and millions upon millions of atoms, all in constant motion, and, under the rule of nature's laws, working harmoniously together for the common good. But even if it was possible, through any device of science or art, to witness the molecular structure and movements of a cell, we would yet be only upon the threshold of our investigation, and would still have much to learn regarding the life history of the cell.

If all the facts of cell life were known, then life itself would cease to be a mystery. It would become as an open book, because a knowledge of cell life carries with it a knowledge of animal and vegetable life, inasmuch as animals and vegetables are simply arrangements, more or less complex, of cells arranged and differentiated, in accordance with natural laws, to perform various functions of the organism. It may, then, be safely asserted that within the compass of a little microscopic cell is concealed the mystery of life, and it is not improbable that life itself had its first manifestation, on this planet, in cell structure. In matters of lineage, the cells are pre-eminently the oldest inhabitants of the world; almost from the beginning of time, certainly from the beginning of organized life, these little bodies have been fighting for existence, and perhaps, like more complex but less humble organisms, have struggled for a betterment of their condition.

I can see no reason why the laws of descent and heredity should not apply with the same force to cell life that they do to organisms of complex cell life. If this is true, and the development of unicellular organisms occurs along the same lines, and is governed by the same laws which control the development of multicellular organisms, then, in the early history of cell life, certain complex molecular substances, favored by the peculiar environmental causes which must have prevailed at the time, developed into a multiplicity and diversity of cells. The differences manifested by the innumerable varieties of cells thus created would depend upon the differences in their molecular arrangements, and would cause the different varieties to develop in different directions ; those varieties which were found to be in best harmony with their surroundings, best fixed in their molecular combinations, best able to successfully resist injurious influences, which perhaps would be fatal to the less favored sort, are the ones which would survive the struggle for existence and be selected by nature for propagation purposes. Now, as these selected varieties would transmit to their progeny their structural advantages, and from this progeny nature would again select the fittest, thus, in accordance with the laws of heredity and selection, there would be a progressive development of selected varieties from generation to generation, through the long period of time since cell life first began. In harmony with, and as a result of, these laws of nature, cells and cellular organisms, in constantly adapting themselves to environmental causes, which themselves have been mutable and have been subject to the laws of progressive development, have passed from the simple to the complex, and from the undifferentiated to the differentiated cell structures. Prominent among the environmental causes which determine the life and development of cells and cellular organisms are climate and cell antagonisms.

Climatic influences are important factors in determining the geographical distribution of bacteria. For the same reason that every country has its own peculiar flora and fauna, it has also its indigenous bacteria. And as the flora and fauna may, by artificial means, be to some extent acclimated in foreign soil, so nature has provided that bacteria, when conveyed to foreign countries, may, under favorable atmospheric and climatic conditions, find in such countries conditions suitable for their growth and multiplication, at least for a time. In these facts are found an explanation of epidemic diseases which at times sweep over the country.

The subject of cell-antagonisms is receiving a great deal of attention from men of science. It is generally conceded that these innocent-looking little bodies do not dwell together in peace—on the contrary, they are constantly warring upon each other. In this "battle of cells," which has been waged since the beginning of cell life, the survivors have learned, or acquired through heredity, certain means of attack and defense. It can be readily seen why qualities thus acquired and transmitted by heredity would be more firmly fixed in the cells of complex organisms, thus giving such organisms important advantages over simpler ones in the battle of cells. It will be observed, however, as in the battles between men, so in the battles between cells, skill does not always succeed against numbers.

In the light furnished by these facts, we will endeavor to explain in what manner, or by what method, the cell excites fermentation and causes decomposition of complex substances.

Picture in your mind's eye the marvelous mechanisms of one of these little cells, with its contained molecules in active motion ; remember the molecules are not in contact, but separated from each other by spaces, which, although infinitely small to our comprehension, are really large when compared with the size of the molecules ; remember, also, that the molecular movements are not of the haphazard sort, but are governed by fixed laws, and that, while similarly constructed molecules have similar modes of motion, there are marked differences, in this respect, between molecules of dissimilar construction. As the molecule receives its motion from its constituent atoms, the cell must receive its energy from its constituent molecules. Remember that atomic and molecular motion constitute force, so that when we speak of cell motion we mean to imply cell force, its power to do work, and the explanation which is offered will follow almost as an inevitable result.

The explanation of differences in cell activities is based upon the law that force, the efficient cause of all physical phenomena, is motion—atomic, molecular or molar ; that heat, light, electricity, attraction and repulsion are simply modes of one and the same motion, which can be converted and changed from one into the other. Now, there is a marked difference in the kind of work which these different forces or modes of motion can do ; for example, electricity can decompose many substances that light does not effect ; on the other hand, light decomposes other substances over which electricity has no power ; while heat, in its decomposing power, has a much larger range of action than either of the others.

The way or method by which these forces do this work, each of its own kind, can be better understood by means of an illustration. When a musical sound or note is made by any instrument, for example, with a violin. in a room containing an open piano, the same note will be sounded by this instrument. Now, sound is a mode of vibratory motion, and, in the example cited, when the string of the violin is vibrated so as to cause a musical note, this vibration is communicated to the surrounding air, and any musical instrument within reach of any of these sound waves, if tuned in unison with them, will be thrown into vibration by them and produce the same note ; the other strings or chords of the piano remain silent for the reason that they do not vibrate in unison with the note made by the violin ; more correctly speaking, only that chord will vibrate whose period of vibration is equal to that of the string.

In the ears of all animals there is an arrangement of rods and hair cells constituting what is known as the organ of Corti; this has been likened to a "harp of a thousand strings." I do not vouch for the supposed resemblance to a harp, but it at least can be asserted that the rods and hair cells are arranged in such a manner that they can vibrate in unison with all vibrations whose period of time lies within certain limits. Some of the rods or hair cells are tuned in unison with one note, that is, they vibrate in the same period of time, while others are vibrated by other notes. In every instance, however, the little rods and hair cells take up the refrain, or are vibrated only by those sound waves having the same period of vibratory recurrence.

Light is another mode of motion, and, like sound, has its waves, which differ among themselves in their periods of recurrence. The different colors of light are produced by the different wave lengths. In the retinal coat of the eye there are little rods and cones which vibrate in harmony with the different wave lengths of light ; some are vibrated by one color and others by other colors. In every instance the vibrations of light must be in unison with that of the rod or cone before the color can be recognized.

When waves of light or heat or water meet other waves of the same substance, in such a manner that the crests of one set will correspond with the crests of the other set, and the troughs of one will correspond with the troughs of the other, the waves will be enlarged, increased in amplitude.

Now, it is assumed that different varieties or species ofcells have molecular vibrations, which, in their periods of recurrence, are distinctive of such species or variety ; hence the molecular movements of cells are influenced in a certain way by other cells whose molecular periods of vibration concide with those of the first in point of time. The wave crest and trough from one cell striking the molecular waves of another cell less firmly fixed in its structure, crest to crest and trough to trough. the motions of the first would necessarily increase the swing of the second until the cell molecules were swung beyond their attractions and the cell disrupted. The cell molecules thus set free would recombine in accordance with chemical laws to form simpler compounds ; for example, in the vinous fermentation the molecular combinations of the yeast cell are so timed in their motions that they can swing the molecules of sugar, held in solution, beyond their chemical attractions, and thus cause a disruption of the sugar ; at the same time the molecules or atoms thus liberated recombine to form a simpler compound, alcohol. Other cells cannot do this work, for the reason that their molecules do not vibrate in the required periods of time. In the same manner the micrococcus aceti decomposes alcohol into acetic acid, and other bacteria perform their special kinds of work and are incapable of doing the work of other varieties. In the same manner, pathogenic bacteria shakes apart certain cellular albuminoid molecules in the blood or tissue of man and animals, while the recombination of molecules thus liberated form poisonous alkaloids called ptomaines and toxines, which are the immediate causes of the symptomatology and pathology of infectious diseases. The decomposition of albuminoid molecules by cell metabolism, principally bacteria cells, and the influences which the products of this action, ptomaines and toxines, have in the causation of disease, is a subject of greatest importance to the physician.

The albuminoid molecules, from whatever source derived, present certain lines of separation, like the lines of cleavage in crystals, along which they are most easily disrupted or shaken apart by cell vibrations ; hence the character of the decomposition product depends along which of these lines separation has taken place. "At least three distinct series of chemical bodies are formed, viz., an acid series, an aromatic series, and a basic series. Out of the innumerable products arising from the action of the bacteria cells upon albuminoid molecules, and which have been extracted and studied, will be mentioned indol, cresol, and skatol in the aromatic series, creatine in the basic, and uric acid in the acid series, serving only as mere examples" (*Journal of the American Medical Association*). "Cells other than those of bacteria are also capable of decomposing albuminoid molecules, and thus produce poisonous substances, *e. g.*, in the physiological changes from albumins to peptones there is a change from innocent to toxic bodies ; this may be illustrated by the hypodermic injection of the digestive leucomaine of pepsin. It occurs practically, when, after the too hearty meal, the liver is unable to care for the excess of digestive leucomaines, and they escape into the general circulation, producing somnolence, lassitude or even stupor" (*Journal of the American Medical Association*).

On this subject Dr. Joseph Leconte says : "The leucomaines, although formed by normal physiological process, are highly poisonous and inimical to health, unless speedily eliminated by appropriate organs. If, now, there should be a failure to eliminate these toxic elements, the results would be similar to those produced by disease germs, except that they would lack the quality of contagiousness, because they are not due to the presence of microbes. The liver is the organ principally concerned in the elimination of leucomaines" (*Journal of the American Medical Association*).

"If alkaloids, by the conjugation of 'S' biliary acids, if carbohydrates they escape the liver, and are taken care of by the blood and pancreas. If belonging to the class of phenols they are combined with a sulphuric radical, and, when that gives out, are then combined with a glycosuric acid, and thus rendered innocuous" (*Journal of the American Medical Association*).

It is thus shown that fermentation may be the result of molecular motion, and that this process would take place whether the necessary vibrations originate in yeast cells, bacteria cells or digestive ferments, which are the efficient cause of normal digestion. The principles involved in each case, the *modus operandi*, are the same in all. At this point, however, the similarity of results existing between the bacteria ferments and digestive ferments ceases. There is an important difference in their biological history, which carries with it an important and practical distinction. I refer to the fact that bacteria and yeast cells are living organisms, capable of multiplying themselves by the generative act, and hence, in the case of pathogenic bacteria, are capable of inducing contagious and infectious diseases. On the other hand, the digestive ferments are molecular combinations, which have no powers of self-multiplication, and cannot cause disease of an infectious or contagious character. There is a wise and beneficent law of wide application, the operation of which controls the course and duration of infectious fevers; this law is based upon the fact that the products of cell decomposition are poisonous which destroy the cells, or the fermentation, or infection which they excite. Thus alcohol is destructive to the yeast cells and the vinous fermentation, while acetic acid, butyric acid, and lactic acid will arrest the fermentations of which they are the products, and, in the same manner, ptomaines and toxines arrest the infectious diseases of which they are severally the causes.

On this subject Dr. Klein says: "One of the most interesting facts observed in the growth of septic micro organisms is this, that the products of the decomposition, started and maintained by them, have a most detrimental influence in themselves, inhibiting their powers of multiplication; in fact, after a certain amount of these products have accumulated, the organisms become arrested in their growth, and finally may be altogether killed."*

Pasteur says: "Many microbes seem to give rise during their breeding to substances having the property to be harmful to their own growth."†

It is evident that the periods of time in which occur the molecular vibrations of any given cell must swing in perfect unison with the vibrations of any other cell, or molecular structure, before the first can swing apart the molecules of the second. Crest must correspond to crest, and trough must correspond to trough, before the one set of vibrations can sufficiently increase the other to cause its disruption. When the arrangement is complete, *e. g.*, the vibrations of the bacteria cell coincide in their periods of recurrence with the molecular vibrations of the albuminoid molecular substance, and decomposition of this results, thus liberating its consistent molecules. It is evident that no new compound can form from these molecules unless its periods of vibratory recurrence do not coincide in point of time with those of the bacterium cells; the same influence which disrupted the albuminoid molecules would prevent the forming of other compounds having the same periods of vibratory motion; in fact, they must be of an opposing kind in order not to be influenced by the bacteria cells. Now, it is again evident that when a ptomaine, possessing a molecular vibration which antagonizes that of the bacteria accumulates in a sufficient amount, the antagonism which it offers will be sufficient to arrest the motions of the bacteria cells, and thus put a stop to the cell metabolism which they caused—in other words, to arrest the disease.

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*Micro-organisms and Disease.

†Comptes rendus, Academy of Sciences, October 26, 1885.

Perhaps this power, which waves or vibrations have of increasing or destroying similar waves or vibrations, may be better understood by reference to instances where waves of sounds and waves of light thus influence each other. Take, for example, two tuning-forks, which have equal periods; when sounded each will give out the same continuous musical sound. Let us, however, change the vibrations in one of the instruments, by attaching some substance to it, or in any other way. The two instruments will no longer vibrate together, the vibrations will not coincide in time, hence the sound that will be given off by them will no longer be a continuous musical note gradually fading away, but will be a rising and falling sound. When the two instruments vibrate together, the sound will be distinct. As one vibrates more rapidly than the other, they will gradually part company, and the sounds which they give out will coincide less and less in point of time as one gains upon the other, and becomes fainter and fainter, and disappear when the wave crest of one coincides to the wave trough of the other. After passing the line, the sound becomes gradually more and more distinct, until it again reaches its acme, when crest and trough coincide to crest and trough of the other side, and thus the sound will rise and fall, depending upon the amount of wave interference or antagonism, until the vibrations are exhausted.

It is thus seen that sound waves can be caused to so act upon each other that, instead of producing sound, they will cause silence. Illustrations could be given, if it were necessary, to prove, that when waves of light are met by other waves of light whose periods of vibrations are one-half wave length behind the first, darkness will be the result. The waves of the one set are quenched or antagonized by those of the other, in accordance with the law of wave interference. This beautiful and important law was discovered by Dr. Thomas Young, one of the most remarkable men the world has produced. Speaking of this law, Sir John Herschel says: "This principle, regarded as a physical law, has hardly its equal for beauty, simplicity, and extent of application in the whole circle of science." The principles involved in this law of interference furnish an explanation why ptomaines are inhibitory, and sometimes poisonous to the bacteria cells which originated them. The amount of antagonism exerted by the ptomaines, in accordance with this theory, would depend entirely upon the extent of interference which its molecular waves would cause in the molecular waves of bacterium cells. As the amount of interference in waves of sound and waves of light varies, and thus produces variable amounts of sound from zero up, there are ptomaines, whose inhibitory power over the actions of cells differs in the same degree and from similar causes.

(*To be continued.*)

MEDICAL BACTERIOLOGY.

BACTERIA OF THE EYE.

PROFESSOR DR. HERMANN COHN.

Gartenlaube, Leipzig, June.

A great many of the diseases of the eye are now known to be due to bacteria; tuberculosis, diphtheria, murrain, etc., may have their seat in the eye as well as in any other organ, but I purpose in the present paper to confine myself to three bacteria which are especially concerned in the generation of eye diseases.

For centuries past physicians and the public have been familiar with a dreaded eye disease known as infantile inflammation of the eye. On the third or fourth day after birth the lids begin to swell, a viscid, yellow matter is formed on the inner surface of the conjunctiva, and discharged at the lids; the cornea is soon attacked and its surface ulcerated, when it either bursts and the contents of the eye are discharged, or it heals perhaps after an illness of weeks' duration; but the transparent cornea is transformed into a white opaque integument with total, or at least partial, loss of vision.

It has long been known that this discharge is infectious. The slightest trace of it in the eye of a grown person will ordinarily destroy the organ in three days, and many physicians have lost their sight while treating infants for the disease.

Statistics show that recently more than a third of the cases of loss of eyesight in German institutes for the blind were due to this pus discharge, or *blennorhœa,* as the disease is commonly termed.

This disease, too, is traceable to bacteria. In the year 1879, Professor Neisser, of Breslau, discovered in the discharge from the eyes of children affected with *blennorhœa,* a characteristic bacteria which he called "gonococci." They have rounded forms and are almost invariably connected in pairs. Under the microscope with methylene blue they take on a bright blue color. They are sometimes seen in mass, sometimes in isolated pairs. A first trace of them is visible in the lids, the moment the child opens its eyes for the first time, and rapidly extends to the eye, penetrating into the cells of the conjunctiva, and causing *blennorhœa.*

Attempts have been made to inoculate animals with this disease, but in vain; the *cocci* are essentially human parasites, and can scarcely find the conditions of existence outside the human body. It has, nevertheless, been found possible to raise pure cultures of them.

As regards the treatment of this dangerous disease of the human eye, prevention plays a more important part than in any other disease. The disease could be utterly eradicated by the adoption of necessary precautions before birth, but, even if this is neglected, the disease is easily removed after birth, if taken in hand promptly. Professor Crede, of Leipzig, made the important discovery in 1880 that a single drop of a quite weak solution of nitrate of silver in the eye was effectual in destroying the *cocci* at once.

This brilliant discovery has led to the practice, in the lying-in institute, of treating every child's eyes in this manner immediately at birth, and while, ten years ago, in my polyclinic we had daily at least half a dozen cases of this disease, weeks will now elapse without a case occurring, and this is generally some country-born child at whose birth no physician was present.

Were this measure uniformly adopted in private practice, the score of wholly blind persons in Europe might be reduced by thirty thousand, and the blind in one eye by a hundred thousand.

Turning now to a second species of bacteria: It has long been known to oculists that when one eye, as a consequence of injury, exhibits a severe inflammation of the iris, that from three to six weeks later, and sometimes even after years, the other uninjured eye becomes inflamed and is almost invariably lost. This disease of the second eye was attributed to sympathy, but it is now known that it is due to the activity of another *coccus* present in all pus, and first described in 1883, by Professor Rosenbach, of Goettingen, who called it the "golden yellow grape coccus," the term "grape" being suggested by the fact that it exists in clusters resembling a bunch of grapes.

Deutschman raised a pure culture of this grape *coccus* and injected a little into the eye of an animal. Before long the *cocci* spread from the eye through the ocular nerve, towards the brain, to the point at which it was intersected by the other ocular nerve which it traversed to the sound eye, where it set up an inflammation similar to what had until then been attributed to sympathy.

The lesson of this discovery is, that since it is impossible to destroy the *cocci* in the eye first diseased, it is better to remove it at once, especially if the sight is wholly or almost wholly destroyed, so as to guard against the possibility of the migration of the *cocci* to the sound eye.

Not less dangerous than the grape *cocci* are the *chain cocci* found in inflammation of the lachrymal gland. When pus forms in this gland it extends to the eye, doing no injury as long as the superficial sheathing of the cornea is uninjured; but a particle of the finest dust getting into the eye and scratching the surface renders it accessible to the pus from the lachrymal gland which sets up a most dangerous inflammation of the cornea which may easily result in the loss of the eye.

It is now well known that it is only through the presence of bacteria that matter or pus makes its appearance in the eye.

Twenty years ago, the most successful oculists were quite unable to account for the fact that after what appeared to be quite a successful operation for cataract, matter made its appearance and the eye was lost. Such an event rarely occurs nowadays, Koch's important discovery that all bacteria are destroyed by a current of steam, having led to the invariable practice of treating surgical instruments in this way before use, to destroy any bacteria that may have alighted on them from the air.

If the *cocci* once effect a lodgment in the eye, their fabulously rapid rate of increase is such that their removal is almost hopeless. Of so much more importance is the discovery of means to guard against their intrusion.

THE DIAGNOSTIC VALUE OF THE DIPHTHERITIC BACILLUS.

BY SIMON FLEXNER, M. D.

Read before the Kentucky State Medical Society at Lexington, Ky., 1891.

In the second volume of the *Mittheilungen aus dem Kaiserlichen Gesundheitsamte,* published in 1884, there is a contribution by Lœffler on the bacterial nature of the disease called diphtheria. He states in this paper that he has isolated in pure culture the organism described by Klebs the year before as occurring in the diphtheritic membrane and considered by him as the cause of the disease, and that he has succeeded in reproducing from inoculations of his pure cultures into susceptible animals a disease possessing anatomical characters identical in all essential particulars with human diphtheria.

At the time of Lœffler's first communications he expressed himself with some reserve on the final point as to whether the organism now known as the Klebs-Lœffler bacillus could be considered the causative agency in production of the disease called diphtheria. But in the time which has elapsed since then one after another of the possible objections to the acceptance of this organism as the cause of primary diphtheria have been removed, and to-day we have, as I believe, in the Klebs-Lœffler bacillus the true cause of the disease.

As Lœffler pointed out, it becomes necessary, in the first place, to distinguish between diphtheria and diphtheritis. He described the first term as indicating "a characteristic and distinct disease due to a specific ens morbi, like measles and small-pox, which has continued constant for centuries, and occurs epidemically" and by the latter term, diphtheritis, he understands exclusively "a definite pathological anatomical form of tissue change which occurs in diphtheria along with other tissue changes."

In his first paper Lœffler could not give an affirmative answer to the crucial question whether the bacilli isolated by him were the undoubted cause of primary diphtheria. Since then all doubt may be said to have been cleared away, so that in 1890 he presented in the *Deutsche Medicinische Wochenschrift* another communication in which he reviews the entire subject, and from the numerous contributions from all of the enlightened parts of the world the conclusion is reached that the bacillus diphtheriæ is the sole cause of primary diphtheria. At this time there was but one discordant series of experiments, that of Pomaden in this country, and it was predicted by Lœffler that the doubt arising from this investigator's observations would be cleared up in time, as he did not believe that a different form of diphtheria prevailed in this country than elsewhere.

In a paper published by Drs. Welch and Abbott in the *Johns-Hopkins Hospital Bulletin No.* 11, 1891, this prediction has been confirmed, for in a number of cases of primary diphtheria occurring in Baltimore, Md., which they examined they found the Klebs Lœffler bacilli, isolated them in pure culture and tested their virulence on guinea-pigs. Finally, Prudden himself has, in a recent number of the *New York Medical Journal*, published his results in a new series of examinations in which he found the bacilli of diphtheria regularly in a number of undoubted cases of the disease.

So it will be seen that in the bacillus of Lœffler we have an organism that is found regularly by all competent observers in different parts of the world in all undoubted cases of primary diphtheria. That by means of this organism the disease can be reproduced in all of its essential and distinguishing features in lower animals, and from these animals it is possible to obtain the bacilli again in pure cultivations.

If the discovery of the bacillus diphtheriæ has shown us that the disease diphtheria is produced by a living organism, it has enabled us also to answer other questions concerning the etiology of this disease.

One of the greatest achievements of the discovery of the bacillus is the proof that the virus develops locally at the site of inoculation only ; that it never invades the blood and organs of the body, and that it is not capable of penetrating into the mucous membrane of the part affected. But if the bacilli develop locally, they are not prevented from producing a soluble poison, which enters the blood and tissues and is capable of giving rise to those grave, constitutional symptoms that are familiar to all. So, if the poison is produced locally, its effects are felt over the entire organism.

The contribution of Oertel, in 1888, on the pathology of epidemic diphtheria, in which he described the peculiar forms of cell death, found in the affected parts of the throat, in the neighboring lymphatic glands, in the spleen, Peyer's patches and mesenteric glands had indicated such an action of the virus. In a series of experiments on susceptible animals, made by Dr. Welch and myself during the past year in the pathological laboratory of the Johns-Hopkins University, we have been able to confirm and extend the observations of Oertel in human diphtheria.

This soluble poison has been isolated in a state approaching purity in very recent times and its properties have been studied somewhat by Roux and Yersin and Fraenkel and Brieger. As might have been anticipated, it has been found to be of peculiar potency. But its mode of action is so new and novel that it has opened up entirely new fields of investigation.

As illustrating the intensity of the poison is the experiment of Roux and Yersin, in which they have been able, by the use of $\frac{4}{10}$ of a milligram of the substance, obtained by evaporating to dryness the active culture fluid, to kill at least eight guinea-pigs weighing each 400 grams, or two rabbits weighing each three kilograms. This poison inoculated into susceptible animals is capable of producing all of the local and constitutional effects of the bacillus sore, the pseudo-membrane ; for the production of this the bacillus is necessary.

As interesting as these facts concerning the soluble poison of diphtheria are, it is the peculiar and most extraordinary property of the poison that when inoculated into animals it may cause no apparent effect for days, and the death of the animal may be delayed for days, weeks and months. This is a new quality in a chemical poison and one of the greatest significance in this instance, for it is clear that although the membrane be destroyed the individual may still die of the effect of poison.

Enough has been said to show that the disease, diphtheria, is both a local and a general disease ; that the primary lesion is a local one, and that the constitutional symptoms are secondary, But they are secondary only in time; in their importance on the bearing of the disease they are of the greatest moment and demand the most careful attention.

Concerning the existence of pseudo-membranous anginas, not diphtheria, it is now quite certain that they do occur; and it is recognized that diphtheria varies greatly in its virulence, so that it is in these doubtful cases that it becomes of the greatest importance to decide definitely their character. For on this knowledge will depend not only the treatment of the case under observation, but, what is more important, perhaps, the measures that will be taken to prevent the spread of the disease to others in the same household and community.

The bacillus diphtheriæ we believe to be the true and the only cause of diphtheria, and we further believe that the discovery of it, the study of its morphology, biology and physiology, has not only enabled us to separate the disease diphtheria from other affections simulating it in appearance, but has provided us with a definite means of diagnosis, and has taught us much concerning the prophylaxis of the disease. Nor is this all; it has given us hints and directions that must lead to the use of wiser and more effective measures of treatment.

The examination of a case of suspected diphtheria for the purpose of diagnosis, while not especially difficult, presupposes a slight acquaintance, at least, with modern bacteriological methods and the possession of a modest bacteriological outfit and a microscope of sufficient power.

The bacillus diphtheriæ is non-motile. It is about the length of a tubercle bacillus and two or three times as broad. Its morphology is among its most striking characteristics, and often renders its identification, even in coverslips made from the false membrane when associated with numerous other bacteria, a comparatively easy matter. It appears variously. It is described by Welch and Abbott as occurring "sometimes as a regular straight or slightly bent rod with round ends; it is especially characteristic to find irregular and often bizarre forms, such as rods with one or both ends swollen and very frequently rods broken at irregular intervals into short, sharply marked segments, with either round, oval or straight sides. Some forms stain uniformly, others in various irregular ways, the most common being the appearance of deeply stained granules in a lightly stained bacillus."

Coverslips are stained with Lœffler's solution of methylene blue. It is, however, the culture method which serves the most effectually for the identification and demonstration of the bacillus. The bacilli grow on blood serum, nutrient agar, gelatine, bouillon, and even on steamed potato. They also find suitable condition for their multiplication in milk. The best medium for their growth is the blood-serum-bouillon mixture of Lœffler, on which they grow with great rapidity. It is prepared by mixing three parts of blood serum from an animal one part of bouillon containing one-per-cent. peptone, one-per-cent. grape sugar, and five-tenths-per-cent. chloride sodium, Next to this they grow best on nutrigent agar—agar containing four to six per cent. of glycerine.

In preparing tubes from the throat it is only necessary to introduce a sterilized platinum needle into the membrane and draw it over the surface of the medium. Several tubes are made in this way and a little of the exudation is rubbed on cover glasses, the latter for immediate examination, whereas the tubes are placed in the incubator until the next day.

The bacilli do not multiply, or only very slowly, below 64° F.; they increase rapidly under favorable conditions at the temperature of the body. They are killed by an exposure to a temperature of 136.4° F. for ten minutes.

The coverslips from the throat may show at once that the bacilli are present, but the cultures on blood serum will show unmistakably the next day. The bacilli of diphtheria grow with such rapidity on this medium that at the end of twenty-four hours a decided growth is found, while other bacteria are often held in temporary abeyance. Coverslips made from this growth are then examined, and if the case is one of diphtheria the peculiar bacilli are readily found in the culture.

To follow further the identification of the bacilli, plate cultures are made on glycerine-agar. The colonies under a low power ($\frac{2}{3}$ in.) of the microscope are characteristic, and if further evidence is desired the culture is tested on a guinea-pig or kitten.

Up to the present I have endeavored to show that diphtheria is a specific disease; that it is the result of the development in the part previously affected of a particular organism—the bacillus diphtheriæ of Klebs and Lœffler; that this bacillus has been isolated in pure culture, and that it is capable of reproducing in animals experimentally the natural disease found in human beings. I have also pointed out that the morphological and biological properties are sufficiently understood to permit of its detection in the parts affected; that it is only found locally in the seat of inoculation, and that it is characteristic of diphtheria as the tubercle bacillus is of tuberculosis; and that in a similar way it may be used as a means of diagnosis.

(The concluding part of the paper is taken up with a consideration of Lœffler's recent and highly important contributions on the prophylaxis and treatment of the disease).—*Med. Progress.*

ANOTHER BACILLUS OF SYPHILIS.

As is well known, Lustgarten, some six or seven years ago claimed to have discovered the specific pathogenetic microbe (a bacillus) of syphilis. About the same time, in fact about simultaneously, Doutrelepont made a similar announcement. The description of the organism was in both cases almost identical—rods of from three to four micromillimetres (*mikrons*) in length, 0.88 mikron in thickness, and resembling very closely the bacillus of leprosy and that of tuberculosis. These rods were sinuous or slightly S shaped, and were very difficult to stain. They were never found free but always congregated in nucleated cells. Lustgarten discovered his specimen in the initial sclerosis and in gummata, while Doutrelepont found the organism in a papular skin eruption and in condylomata. He subsequently detected them in the initial lesion. Gentian violet was the staining agent used in both series of experiments. Notwithstanding the subject was eagerly taken up by a number of trained experimenters (Gottstein, Klebs, Birch-Hirschfeld, Martineau, Hamonic and others) the matter remains just about where it was when Lustgarten published his work (in the

Wiener Medizinische Presse, if I remember aright) "Die Syphilis Bacillen," and pathologists to-day are very skeptical as to the existence of the so-called syphilis bacillus. The writer hereof by following the staining formulæ of Lustgarten* has found in sections of a syphilitic condyloma violet stained bacilli answering closely to the description given above. Very recently, however, a new claimant for the honor of demonstrating a pathogenetic bacillus of syphilis has made his appearance in the person of Dr. Thomas von Marschalko of Buda-Pesth, and bath surgeon (*bade-arzt*) at the watering place Lipik, who claims to have discovered it in the secretions of syphilitics, and he gives the following method for the demonstration of the micro-organism *in situ,* in chancres, and syphilitic nodosities, etc.: "The material first hardened in alcohol is placed in an alkaline solution of methyl blue and left there, at an ordinary temperature, for thirty-six hours or longer. It is then rinsed with water and placed in a concentrated aqueous solution of vesuvin, and allowed to become deeply colored. Taken out, rinsed and sectioned, and examined in balsam or dammar, the bacilli will be found colored a deep blue, which shows very sharply against the brown colored tissues. The bacilli are always found in characteristic groups." This much we learn from a report of a discussion which took place in the Buda-pesth Medical Society between Dr. Marschalko, on the one side, and Professor Schwimmer and Drs. Wohl, Pertik and Makara on the other. The latter gentlemen were not willing to accept Dr. Marschalko's premises, and insisted, very wisely and justly, that the demonstration of certain bacilli in certain growths incident to syphilis by no means proved the "find" to be pathogenetic and causative. It will, of course, be necessary for Dr. Marschalko to isolate the living microbe, make pure cultures, and cause syphilis by inoculation with the latter before we can accept his discovery as a veritable one. *St. Louis Medical & Surgical Reporter.*

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* LUSTGARTEN'S STAINING PROCESS.—Dissolve eleven parts of a saturated alcohol solution of gentian violet in one hundred parts of anilin water. Let the sections or other material lie in this for two or three hours. Remove and wash in absolute alcohol for four or five minutes and transfer to a solution of fifteen parts of potassium permanganate in 1,000 parts of water. Let remain for ten minutes and finally transfer for a moment to a concentrated aqueous solution of sulphurous acid. If at the end of this process the sections are not bleached repeat the entire process from the absolute alcohol on. Dehydrate the bleached sections with absolute alcohol, clear with clove oil or benzol and mount in dammar or balsam.

SURGICAL BACTERIOLOGY.

A NEW ANTISEPTIC.

At the Academie de Medecine, on April 28, M. Polaillon read a paper contributed by Dr. Berlioz, of Grenoble, on a new antiseptic agent called "microcidine," which is composed of seventy-five per cent. of naphtholate of sodium and twenty-five per cent of naphthol and phenyl compounds. It is a white powder obtained by adding to fused *B*-naphthol half its weight of caustic soda, and allowing the mixture to cool. It is soluble in three parts of water, and the solution, which is cheap, is said to possess considerable antiseptic powers, without being toxic or caustic or injurious to instruments or linen. The antiseptic properties of microcidine, while inferior to those of corrosive sublimate or naphthol, surpass those of carbolic and boracic acids ten and twenty times respectively. Microcidine is eliminated by the kidneys, and is antipyretic.

M. Polaillon has experimented with this new agent largely in his wards as a dressing to recent and other wounds, utilizing as a dressing, after a preliminary cleansing of the raw surface with a three-per-cent. solution, gauze soaked in the same and covered with a layer of oil silk and a thick pad of cotton-wool. The results are reported to have been excellent.—*Lancet.*

HOW TO STERILIZE INSTRUMENTS WITHOUT CAUSING RUST.

Von Bergmann recommends boiling cutting instruments in a one-per-cent. solution of carbonate of sodium for five minutes.

By means of this solution rust is prevented, although the instruments may be rendered perfectly aseptic. After boiling, they are removed with sterilized gauze at the time of the operation. In this manner all antiseptic solutions are done away with. An indefinite contact of the instruments with this solution will not cause rust.—*Lancet-Clinic, Cincinnati.*

HYGIENIC BACTERIOLOGY.

BACTERIA.

BY DR. KLEIN.

The first of a series of three lectures on bacteria; their nature and functions, was delivered at the Royal Institution on Tuesday last by Dr. E. Klein, F. R. S. He said that perhaps in no branch of biological science had advances in the methods of research within the last twenty-five or thirty years been so enormous as in this subject. In 1828 Ehrenberg recognized the existence in water of minute mobile organisms which he considered to belong to the group of animalculæ known as infusoria, an assumption which was now known to be erroneous. In 1837 Schwann demonstrated the presence in atmospheric air and in dust of living microscopic beings, which he showed by direct experiment to be endowed with the power of producing in certain fluids those chemical changes termed alcoholic fermentation or putrefaction. Pasteur fully established the proposition that the different fermentations, such as alcoholic, butyric, acetous, mucous, and lactous fermentations, and also the decomposition of putrescible matter, were caused by definite and different species of such minute living beings—microbes, and that without them such changes did not occur. This proposition implied that these changes were dependent on and ultimately bound up with the life and growth of these microbes, and if these were prevented from gaining access to such fermentative matters, they would remain unchanged or sterile. This was the principle which Sir Joseph Lister had applied in surgery, with the well-known brilliant results. The *role* of these microbes in atmospheric air had been minutely worked out and beautifully illustrated by Professor Tyndall, whose share in finally establishing that with these simple organisms, belonging almost to the world of the infinitely small, the same fundamental principle obtains as in other living organisms of plant and animal life, be they ever so large and complex, namely, that each organism had descended from an antecedent parent organism, and that no such thing as their origin from non-living matter occurred. Within comparatively recent times it had been shown that a variety of the most important and extensive processes of oxidation and reduction occur in nature, such as the oxidation and resolution of dead animal and vegetable matter, the breaking up of complex nitrogenous materials—such as albuminous substances, and their ultimate change into nitrites and nitrates, so essential to the life and growth of plants; that specific fermentation, so important in food stuffs and articles of diet, and many other processes, are caused by, and intimately connected with, the growth and life of microbes. Though the importance of some species as useful agencies in nature is recognized, the importance of other species, as being the cause of disease affecting plants, animals and man, is not less. The term micro-parasite is given to this latter group. Amongst the microbes there is one great group to be dealt with in particular, called "bacteria," because it possesses more or less the shape of a minute rod. Like the true or higher fungi, they are free from chlorophyl, and are composed of cells, a cellular membrane with living matter or protoplasm within, and they multiply by fission, for which reason they are called "fission fungi." Bacteria could then be defined as microscopic elementary organisms, composed of a cellulose investment of the protoplasmic contents, and which multiply by simple fission. They are classified into micrococci or cocci, bacilli and spiral vibriones, according to whether they are spherical, cylindrical, or curved and spiral. The lecturer exhibited a large number of micro-photographs of bacteria, prepared by Mr. Andrew Pringle and Dr. Bousfield.

All these organisms, when they have found suitable nidus, multiply with enormous rapidity. It has, for example, been found from observation—all conditions of moisture, medium and temperature being favorable—that some multiply in twenty minutes, others in thirty minutes, and others in forty minutes. Staphylococcus aureus, which in its growth produces a peculiar golden-colored filament, grows with great rapidity when sown in a medium-like, faintly alkaline broth at a temperature of 98.6° F. Into a sterile broth tube a definite number of organisms are put—say, eight cocci per cubic centimetre. If placed in an incubator for twenty-four hours at 98.6° F. and then counted, it is found that 1 cc. contains 640,000—that is to say, one organism has multiplied eighty thousandfold in the first twenty-four hours. It would not be expected that the same rate would obtain in the second twenty-four hours, because the material had been used up. After forty-eight hours' growth the counting yielded 248,000,000 per cubic centimetre—that is, only four hundredfold. In seventy-two hours it was found that there were 1,184,000,000 per cubic centimetre—that is to say, during the last day each had multiplied only fivefold. As the material is used up the rate of multiplication decreases. Another instance of the rapidity of growth was given. A rabbit was inoculated subcutaneously with 20,000 bacilli of fowl cholera, and died in twenty-four hours. It was found that 15,150,000 microbes were contained in 1 cc. of the blood of the animal. The whole of the blood contained twelve hundred millions, showing that each bacillus in twenty-four hours had multiplied sixty thousand times. Those organisms which have their habitat in ordinary temperature grow very rapidly. Professor Ferdinand Cohn was the first to study the rate of multiplication on the hay bacillus. He calculated that in two days the number of these would be so great that the whole Atlantic Ocean would be densely peopled by them if there was sufficient nutriment, which, fortunately, there is not, and, therefore, many of them had to go to the wall.

By the motility of bacteria is understood active locomotion. They spin round, they dart to and fro, and pass rapidly over the field of the microscope, and that is on account of their possessing one, two, three, or even a multitude of fine hairs. The organism of typhoid fever possesses several of these flapellæ. It has been shown that for retaining this motility a plentiful supply of oxygen is required. If, in a chamber, at one end oxygen is supplied, and at the other nitrogen or hydrogen gas, the organisms will all move towards the end where the oxygen is. If the oxygen is replaced by nitrogen or hydrogen the movement gradually ceases. If water is covered with a scum, it is most probably a motile bacillus which grows in the fluid, and which is driven to the surface, where it can derive the best supply of oxygen. In many cases the motility of the organisms is interfered with by their own chemical products.

Within certain of these organisms, but not in all, are formed peculiar corpuscles, which bear the same relation to the organisms as the seed does to the plant. This spore formation is almost entirely limited to the order of bacilli, and in this group there are very many species which do not possess this power. In a number of different species of bacilli, some of which are capable of forming spores and others not, those which have this power may look on very quietly, while those that do not will exhaust all the nutritive material present, growth and multiplication will then cease, and they will gradually die away. Those which form spores have a much better chance of bringing forth new generations than the others.

When organisms do not find suitable materials for their growth, certain changes are brought about called "involution changes." When the bacillus ceases to possess that high degree of vitality that the normal typical bacillus possesses, it gradually undergoes changes which lead to its death. Illustrations were given of what had been described as involution changes, but which were not so. For instance, tubercle bacilli grown under not very favorable conditions may be swollen, and others may appear branched. Some observers took these changes to indicate the death of the organism, but the lecturer was not quite sure that such were "involution changes."

In all these considerations, particularly in reference to the formation of spores, there were a number of facts of very considerable practical importance. The germination of those organisms which form spores takes place on the same principles as the germination of the spores in the higher fungi. The envelope is broken, the protoplasm contained within it shoots out in the shape of a rod, which when it is fully formed elongates, divides and multiplies as in the case of the parent. In this way one bacillus, by repeated multiplication, forms a new crop. When these have reached a certain phase of development they again form spores which go to start a new generation. These spores have a much greater power of resistance than is possessed by the non-spore-bearing organisms, and can withstand high temperature, dryness and the influence of light, so much so that it has become almost a recognized method of determining whether a particular species of bacilli forms spores by subjecting the suspected organism to a temperature of 203° F. or 212° F. If they survive this exposure, and if they survive drying, it may be taken as established that the growth is spore-forming.—*Lancet.*

TUBERCULAR INFECTION FROM MILK.

A great deal has been recently said by many prominent members of the profession, concerning the inutility of adapting extreme measures for the prevention of tuberculosis, some of whom have held that both tuberculous meat and milk may be partaken of with impunity and without harm to the consumer. The following case, which we quote from the *Allgem. Medicinischen Central-Zeiting*, will be of interest to optimistic members.

The case was recorded by Dr. Ollivier in a recent meeting of the Academie de Medicine of Paris. The patient was a young woman, twenty years of age, with acute meningitis. The girl was of a strong constitution, and had no constitutional trouble. She had been educated at a boarding school. Upon inquiry, it was learned that within the course of a few years, thirteen pupils in the same school had been infected with tuberculosis, and six had died. The milk supplied to the school was from cows kept on the place. Upon examination these animals were found to have tubercular ulcers on their udders, and after being slaughtered were found to be generally infected by the disease.—*Medical and Surgical Reporter.*

BACTERIA IN DRINKING WATER.

Dr. W. Migula (*Centralbl. fur Bakt. und Parasitenk. Bd. VIII, No.* 12. *p.* 353) makes a contribution to our knowledge of this subject which is really a new departure as regards the examination of drinking water. He points out that, although considerable stress has been laid on the examination of water for pathogenic organisms, there is no reliable rule to guide the hygienist in his examinations for the ordinary saprophytic organisms and their relation to the purity of water to be used for drinking purposes. Dr. Migula washes out small flasks with bichloride of mercury, then, after rinsing them with the water to be examined, he leaves a specimen in the flask, which is plugged with sterilized cotton wadding and covered with an india-rubber cap. It is not necessary to pack the flasks in ice as it is assumed that if any of the organisms multiply they will all do so, whilst if the putrefactive organisms (those that liquefy gelatine) grow more rapidly than the others, independent evidence is obtained of the impurity of the water. Cultivations are made in flat glass dishes in order to save the time required in manipulating plates and tubes during the cooling process. After examining four hundred springs, wells and streams the author has come to the conclusion that where there are more than ten species in any sample of water, especially when these are not species ordinarily met with, the water should not be used for drinking purposes. He found that only in fifty-nine waters was this the case, but that one hundred and sixty-nine waters contained more than 1,000 organisms per cubic centimetre, sixty-six of these having over 10,000 (forty over 50,000). From these figures it will be seen that some of the sources of supply would be condemned by the old method but would be passed by the new, and some condemned by the new would be passed by the old. Migula found in all twenty-eight species, and in a series of tables he brings out the fact that the number of colonies does not by any means correspond with the number of species, though in some cases it undoubtedly does so. This is, in fact, an exceedingly variable quantity. It also comes out that putrefactive bacteria are almost invariably absent from spring water;

that they are most frequently found where the number of species is great, and where the number of colonies is between 1,000 and 10,000 per cubic centimetre; that they also occur where the number of germs is below fifty per cubic centimetre, but very seldom where the number is over 10,000.

Dr. L. Schmelk, who recently (*Centralbl. fur Bakt. und Parasitenk., Bd. IV, No. 7, p.* 195) pointed out there is a great increase in the number of bacteria in the water supply of Christiana during the period that the upland snows are melting most actively, now (*Centralbl. fur Bakt. und Parasitenk. Bd. VIII, No.* 4, *p.* 102) gives further evidence collected, during the last three years in proof of his theory. The numbers he finds for those years were 10 or 15 per cubic centimetre in March to 2,500 in April, 1888; 1,100 in 1889, and on March 28, 1890, 5,000; the breaking up of the winter snows having occurred this year much earlier than usual. This is the period during which the winter snows are melting, and after this is completed there is no marked increase in the number of bacteria in the lake water until the reappearance of the winter snows, some of the earlier falls of which during October, November, and December melt and disappear. In December the number of bacteria per cubic centimetre sometimes reaches 600, the highest point recorded during the year except in March. Dr. Schmelk thinks that the increase is due to the action of frost in breaking up the earth's surface, from which the contained organisms may be set free as soon as a thaw occurs and then washed away along with the surface soil just as during great rain-storms. He also points out that the masses of ice projecting into a river may form "collecting" points for the particles suspended in the flowing water, as more bacteria are always found in the water obtained from such ice when melted than in the river water itself. He verified this by repeated experiments. He found, however, that when floating ice was melting in water though it contained a few more organisms than water collected near the surface, it held far fewer than water taken from a considerable depth. In the Christiana water-supply he found some thirty species of bacteria, some of which occurred very seldom, some at certain periods of the year only, and a few all the year round. The amount of solids in the water varies from time to time, between 0.92 and 0.94 grams per liter, and traces of ammonia can usually be found in water during the time that it contains most bacteria. —*Supp. British Medical Journal ; Microscopical Journal.*

SELECTIONS. *

PARASITIC-ORGANISMS IN THE DISEASED CRYSTALLINES AND ON THE POSSIBLE ROLE OF THESE ORGANISMS IN THE PATHOGENY OF CERTAIN OCULAR AFFECTIONS. †

BY MESSRS. GALLIPPE AND L. MOREAU.

Starting with this principle that the calcifications of pathological tissues is (the result of) microbic function, we proposed to seek, if, in the cataract of crystalline, susceptible of undergoing a calcareous transformation, or in the eyes long since ruined, and in which we find some calcareous concretions, there existed any micro-organisms.

We proposed to study also if we could attribute to a parasitic origin those singular entoptic phenomena, known under the name of *muscœ volitantes.*

In the great majority of cases, we have found some parasites in the crystallines affected with cataracts. Without wishing to attribute to them an exclusive *role* in the pathogeny of the cataract, we think that these parasites are not disinterested in the production of opacity of the crystallines.

We have also encountered micro-organisms in the calcareous concretions existing in the eyes lost for a long time.

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* Dr. Loeb will continue his article, "Translations from the German," pages 518–521, July number in September number, because his manuscript was not quite ready for this issue.—EDITOR.]

† Original communication to the French Academy of Sciences.

Finally without desiring, in this last point, to go beyond the limits of hypothesis, we think, in basing ourselves on arguments of a physical order, that the intra-ocular foreign bodies known as muscæ volitantes might well be of parasitic origin.

Our researches have led us to some therapeutical conclusions. If it is demonstrated, as we think it will be, that we should reckon on the intervention of the parasites in the production of certain ocular affections, such as the cataract, sympathetic ophthalmia, etc., the antiseptic treatment of the extra and intra-ocular affections imposes itself rigorously on the physicians.—*La Tribune Medicale.*

INFECTIOUS THYROIDITIS. *

BY MESSRS. TACŒL AND KÜMMEL.

The first case was a woman of twenty-six years, with whom the goitre developed itself at fourteen years. Once the tumor became the seat of an acute inflammation accompanied by dyspnœa so intense that it was necessary to remove the right half of the tumor. The portion removed was composed of two cavities: one filled with colloid substance, the other with a greenish-yellow liquid in which the microscope and cultures revealed the existence of the Eberth bacillus in great numbers.

This observation confirms then the pyogenic properties of the typhic bacillus as had already been observed in a certain number of cases of periostitis and suppurative ostœ-myelitis.

The second case was a woman of thirty-one years in whom the goitre augmented in volume at each pregnancy. After the last pregnancy the tumefied goitre became swollen, the seat of inflammatory phenomena complicated with attacks of suffocation. We made the ablation of the right lobe of the tumor, and found an abscess of streptococci.

These observations confirm the facts put in evidence for sometime, *i. e.*, that besides the ordinary agents of suppuration there exists some accidental agents. Suppuration then in certain cases has a multiple origin.—*La Tribune Medicale.*

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* Original communication to the Paris Surgical Society May 20, 1891.

THE CHEMICAL FACTORS IN THE CAUSATION OF DISEASE.

BY VICTOR C. VAUGHAN, M. D., PH. D., OF ANN ARBOR, MICH.

Professor of Hygiene and Physiological Chemistry and Director of the Hygienic Laboratory in Michigan University.

(*Continued from July Number.*)

LECTURE III.—THE AUTOGENOUS DISEASES.

All living things are composed of cells. The simplest forms of life are unicellular, and in these all the functions of life devolve upon the single cell. Absorption, secretion and excretion must be carried on by the same cell. A collection of unicellular organisms might be compared to a community of men with every individual his own tailor, shoemaker, carpenter, cook, farmer, gardener, blacksmith, etc. However, only the lowest forms of life are unicellular ; all others are multicellular. In the higher animals there is a differentiation not only in the size and structure of the cells, but in the labor which they perform. The body of man may be compared to a community in which labor has been specialized. Certain groups of cells, which we designate by the term "organ," take upon themselves the task of doing some special line of work, the well-doing of which is essential to the health, not only of that group, but of other groups as well, or of the body as a whole. There is an inter-dependence among the various organs. Certain groups of cells supply the fluids or juices which act as digestants, and among these there is again a division of labor. The salivary glands supply a fluid which partially digests the starch of our food ; the peptic glands supply the gastric juice which does the preliminary work in the digestion of the proteids ; while the pancreatic juice completes the digestion of the starches begun in the mouth, of the proteids begun in the stomach, and does the special work of emulsifying the fats. But even some of these products of complete digestion would be harmful should they enter the circulation unchanged. The peptones must be converted into serum-albumin by the absorbing mechanism of the walls of the intestines, and, while 10 per cent. of the fat of the food is split up into glycerine and fatty acids by the action of the pancreatic juice, a much smaller per cent. enters the thoracic duct in this divided form. The food may be taken in proper quality and quantity ; the digestive juices may do their work promptly and properly, but, if the absorbents fail to perform their functions properly, disease results. It may happen that the failure lies in improper or imperfect assimilation and the result becomes equally disastrous, and with the effects of non-elimination we are fairly conversant. Of the myriads of cells in the healthy human body there are none which are superfluous. It is true that, among these ultimate entities of existence, death is constantly occurring, but in health regeneration goes on with equal rapidity and each organ continues to do its daily and hourly task. The microscope has made us familiar with the size and shape of the various cells of the body, and the students of pathology have described the alterations in form and size characteristic of various diseased states. But we must remember that in the study of these ultimate elements of life there are other things, besides their morphological history, to investigate. They are endowed with life, and they, as well as the germs which we have been studying, have a physiology and chemistry which we know but slightly. They are influenced beneficially or harmfully, as the case may be, by their environment. They grow and perform their functions properly when supplied with the needed pabulum. They are not immune to poisonous agents. They are injured when the products of their own activity accumulate about them.

The object in writing this lecture has been to collect what evidence I may concerning those diseases which arise from imperfect or improper activity of the cells of the body, not due to the introduction of foreign cells. To designate this class of diseases I have selected the word *autogenous*, and I understand that in these diseases the materies morbi is a product of some cell of the body, and not, as in the case of the infectious diseases, of cells introduced from without the body.

It is true, without exception so far as I know, that the excretions of all living things, plants and animals, contain substances which are poisonous to the organisms which excrete them. A man may drink only chemically pure water, eat only that food which is free from all adulterations, and breath nothing but the purest air, free from all organic matter, both living and dead, and yet that man's excretions would contain poisons. Where do these poisons originate? They are formed within the body. They originate in the metabolic changes by which the complex organic molecule is split up into simpler compounds. We may suppose—indeed, we have good reasons for believing—that the proteid molecule has certain lines of cleavage along which it breaks when certain forces are applied, and that the resulting fragments have also lines of cleavage along which they break under certain influences, and so on until the end products, urea, ammonia, water and carbon-dioxide are reached; also that some of these intermediate products are highly poisonous has been abundantly demonstrated. The fact that the hydrocyanic acid molecule is a frequent constituent of the leucomaines is one of great significance. We know that chemical composition is an indication of physiological action, and the intensely poisonous character of some of the leucomaines conforms to this fact. It matters not whether the proteid molecule be broken up by organized ferments (bacteria), or by the unorganized ferments of the digestive juices, by the cells of the liver or by those still unknown agencies, which induce metabolic changes in all the tissues—in all cases poisons may be formed. These poisons will differ in quality and quantity according to the proteid which is acted upon, and according to the force which acts.

Peptones formed during digestion do not in health reach the general circulation. When injected directly into the blood they act as powerful poisons. They destroy the coagulability of the blood, lower blood-pressure, and in large quantities cause speedy death. Brunton attributes the lassitude, depression, sense of weight in the limbs and dullness in the head occurring in the well-fed, inactive man, after his meals, to poisoning with peptones. The remedy which he proposes is less food, especially less nitrogenous food, and more exercise. That some substance resulting from the proteids of the food is the cause of this trouble Brunton thinks is evidenced by the fact that the weakness and languor are apparently less after meals consisting of farinaceous foods only.

That peptone finds its way into the general circulation frequently is shown by its detection in the urine in many diseased conditions, some of which are infectious and others autogenous in character. However, propeptonuria, or albumosuria, is more common than peptonuria, and we have already seen that many of the bacterial albumoses are among the most highly poisonous bodies known, but the action of the albumoses formed during digestion has not, so far as I know, been studied. The valuable work of Kuehne and Chittenden on the chemical character of these bodies should be supplemented by a thorough investigation of their physiological effects when injected into the blood. It is more than probable that valuable information would be secured by such studies. That albumose is frequently found in the urine is shown by the following list of diseases in which it has been observed, given in the last edition of the work of Neubauer and Vogel on the urine. Koesner has found it in spermatorrhœa ; Koeppen, in mental diseases without spermatorrhœa ; Kahler, in osteomalacia ; Bence Jones, in multiple myeloma ; Senator and others, in dermatitis, intestinal ulcer, liver abscess, croupous pneumonia, apoplexy, vitium cordis, resectio coxæ, parametritis, endocarditis, typhoid fever, nephritis, phthisis, etc.; Loeb, in measles and scarlet fever ; Leube, in urticaria ; and Lassar, after inunctions of petroleum. Koettnitz, Furstner and others find albumose frequently in the urine in mental diseases. Evidently there is much to learn from the study of the conditions accompanied by the elimination of the albumoses in the urine. It is more than probable that the acute Bright's disease following scarlet fever, diphtheria, and the other acute infectious diseases, owes its existence to the poisonous albumoses of these diseases. Prior has recently shown that undigested egg albumin is sometimes absorbed and produces marked disturbances. A boy, after eating sixteen raw eggs, had a high fever accompanied by the appearance of both albumin and hæmoglobin in the urine.

Brieger obtained by digesting fibrin with gastric juice a substance which gives reactions with many of the general alkaloidal reagents, and to which he has given the name "peptotoxine." A few drops of a dilute aqueous solution of this substance sufficed to kill frogs within fifteen minutes. The frogs became apparently paralyzed and did not respond to stimuli. Slight tremor was perceptible in the muscles of the extremities. Rabbits of about one kilogram weight were given from 0.5 to 1 gram of the extract subcutaneously. About fifteen minutes after the injection, paralysis beginning in the posterior extremities set in ; the animal fell into a somnolent condition, sank and died. In some rabbits several hours elapsed before the above-mentioned symptoms appeared.

Peptotoxine was found by Brieger to be formed not only by the digestive juice, but to be among the first putrefactive products of proteids, as fibrin, casein, brain substance, liver and muscle.

It is highly probable that many of the nervous symptoms which accompany some forms of dyspepsia are due to the formation and absorption of poisonous substances.

In some persons the tendency to the formation of poisons out of certain foods is very marked. Thus, there are some to whom the smallest bit of egg is highly poisonous ; with others, milk will not agree ; and instances of this kind are sufficiently numerous to give rise to the adage, "What is one man's meat is another man's poison."

Brunton is of the opinion that the condition which we term "biliousness," and which is most likely to exist in those who eat largely of proteids, is due to the formation of poisonous alkaloids ; but of this we have no positive proof.

Whether or not the unorganized digestive ferments ever find their way into the blood in quantity sufficient to cause deviations from health, we are not in a position to state definitely. The older physiological chemists teach us that pepsin and trypsin are frequent, if not constant, constituents of normal urine, but their experiments were made without any reference to the possibility of the ferments which they found being formed by the bacteria of the urine, and after carefully going over the literature of the subject I am not prepared to pass judgment on the truth of their statements. However this may be, the fact that these ferments manifest a marked toxicological effect when introduced into the blood is of great interest, especially at this time. Hildebrandt has recently reported the results of some experiments made by himself upon this subject. He find that a fatal dose of pepsin for dogs is from 0.1 to 0.2 gram per kilogram of body weight. The subcutaneous injection of these quantities is followed by a marked elevation of temperature, which he designates as "ferment fever." This fever begins within an hour after the injection, reaches its maximum after from four to six hours, and may continue for some days. On the day preceding death, the temperature generally falls below the normal. During the period of elevation there are frequent chills.

The symptoms which accompany the fever vary somewhat with the species of animal. Rabbits lose flesh, notwithstanding the fact that they continue for a while to eat well, become very weak and death is preceded by convulsive movements. Dogs tremble in the limbs, become uncertain in gait, and vomiting, dyspnœa and coma are followed by death.

On section there is observed parenchymatous degeneration of the muscles of the heart, and similar changes in the liver and kidneys. There are abundant hæmorrhages in the intestinal canal, in Peyer's patches, in the mesenteric glands, and in the lungs in cats. Thrombi are frequently found in the lungs, and in some cases in the kidneys.

The effect upon the coagulability of the blood is worthy of note. At first there is a period during which the coagulability of the blood is greatly lessened, then follows a period of greater rapidity in coagulating, and it is in this latter stage that the thrombi are formed.

These experiments are interesting, not only as a possible explanation of the cause of some of the autogenous fevers, which will be discussed later, but in view of the present tendency to inject such complex animal solutions as Brown-Sequard's elixir and Koch's lymph subcutaneously, and they will probably cause us to exercise a little more care in this direction.

That certain febrile conditions are autogenous there can be no doubt. These, like other diseases originating within the system, may be due to either of the following causes: *First.*

There may be an excessive formation of poisonous substances in the body. Thus, Bouchard has shown that the urine excreted during the hours of activity is much more poisonous than that excreted during the hours of rest. Both physical and mental labor are accompanied by the formation of these deleterious bodies, and if the hours of labor are prolonged, and those of rest shortened, there will be an accumulation of effete matters within the system. *Second.* The accumulation of the poisonous matters may be due to deficient elimination. *Third.* Some organ whose duty it is to change harmful into harmless bodies may fail to properly perform its functions. Illustrations of diseased conditions arising from these several causes will be given.

First, we may mention fatigue fever, which is by no means uncommon, and from which the overworked physician not infrequently suffers. One works night and day for some time; elimination seems to proceed normally; but after a few days there is an elevation of temperature of from one to three degrees, the appetite is impaired, and then, if the opportunity for rest is at hand, sound and restful sleep is impossible. The tired man retires to his bed expecting to fall asleep immediately, but he tosses from side to side all night, or his sleep is fitful and unrefreshing. The brain is excited and refuses to be at rest. The senses are alert and all efforts to sink them in repose are unavailing. Fatigue fever is frequently observed in armies upon forced marches, especially if the troops are young and unaccustomed to service. Mosso has studied this fever in the Italian army. He states that in fatigue the blood is subjected to a process of decomposition brought about by the infiltration into it from the tissues of poisonous substances, which when injected into the circulation of healthy animals induce malaise and all the signs of excessive exhaustion. It is possible that in this decomposition of the blood the fibrin-ferment, which, according to Schmidt, is held in combination in the colorless corpuscles, is liberated; and it has been shown by Edelberg, that the injection of small quantities of free fibrin-ferment into the blood causes fever, while the injection of larger quantities is followed by the formation of thrombi, as has been demonstrated by the experiments of Edelberg, Bonne, Birk and Koehlar.

Fatigue fever is often accompanied, especially during the period of elevation, by chilly sensations, and consequently it is pronounced malarial and quinine is administered, but it does no good, often harm by increasing cerebral excitement. The proper treatment is prolonged rest with proper attention to elimination.

Then there is the fever of exhaustion, which differs from fatigue fever only in degree. It is brought on by prolonged exertion without sufficient rest and often without sufficient food. The healthy balance between the formation and elimination of effete matter is disturbed, and it may be weeks before it is re-established ; indeed, it may never be regained, for some of those cases terminate fatally. The fever of exhaustion may take on the typhus form, delirium may appear, muscular control of the bowels may be lost and death may result.

That the fever of exhaustion has been mistaken for typhoid by some of the ablest clinical teachers is shown by Peter in the following quotation : "It was in 1852," says he, "when entering upon my clinical studies, and ardent in my attendance at the clinic of Chomel, I was witness of the following instance : A young man was received under the celebrated professor's charge, suffering from prostration, muscular pain and rachialgia. Chomel made the examination with all the care and attention used by him, then, as was also usual with him, in the presence of the patient, he gave the diagnosis in Latin, which was *aut febris peyerica aut variola incipientis*, either typhoid fever or incipient small-pox. I felt rather dissatisfied at a diagnosis so little precise, by one so eminent in his art. The truth of the matter was, though Chomel was not aware of it, this young fellow in a state of destitution had walked from Compeigne to Paris, sleeping by the wayside at night and nourishing himself with such refuse food as chance supplied. It was under such circumstances the patient had developed febrile symptoms. The day after his admission, and simply from rest in bed, he felt better, and the day following he was altogether well."

That all cases of the fever of exhaustion do not terminate so rapidly as that instanced above by the great French teacher, is shown by one which I happen to have under my care at the present moment. A lady, rather frail in body, but without any organic disease, spent the greater part of the time day and night for ten days in the sick-room of her child who died with diphtheria. Since the death of the child, the mother has been confined to her bed with a fever which varies from 99° to 102.5°. She has no soreness of throat or other evidences of infection with diphtheria. She has no symptoms of typhoid fever, and with the exception of slight constipation, which has been easily relieved, her bowels have remained in good condition. She took but little food during the sickness of the child and has had no desire for food since. Her temperature is but slightly affected by two-grain doses of antifebrin and the highest point reached each day is very variable. The mind is clear and she has been altogether free from headache. Her temperature is lowered by a few hours' sleep. This condition has now continued for nineteen days. I have pronounced this a case of fever from exhaustion, and, if this diagnosis is not correct, I must admit that I do not understand the nature of the case.

A case, similar to the above, I saw some time ago in a young man who had been leading quite an inactive life as a student, and who did a very foolish thing in walking one day a distance of more than thirty miles. The next morning he had a fever, which varied from 99° to 103°, and which continued for more than one month. The physician in charge pronounced this a case of typhoid, but of the correctness of his diagnosis there was not the slightest evidence. In this instance, quinine was first employed, but it increased the wakefulness and restlessness, and was followed by an elevation in the temperature.

I have known at least one case of this kind to terminate fatally, and a most thorough *post-mortem* examination failed to reveal any definite lesion.

Then, again, there is the fever of non-elimination, which all physicians of experience have observed. There is a feeling of languor, the head aches, the tongue is coated, the breath offensive, and the bowels constipated. The physician fears typhoid fever, but finds that a good, brisk cathartic dissipates all unpleasant symptoms, and the temperature falls to the normal. This fever is also liable to appear among those who are confined to bed from other causes. Brunton says: "No one who has watched cases of acute diseases, such as pneumonia, can have failed to see how a rise of temperature sometimes coincides with the occurrence of constipation, and is removed by opening the bowels." The surgeon and obstetrician have often had cause to rejoice when they have found a fever, which they feared indicated septicæmia, disappearing after free purgation.

Bouchard has shown that normal fæces contain a highly poisonous substance, which may be separated from them by dialysis, and which, when administered to rabbits, produces violent convulsions. He estimates that the amount of poisonous alkaloids formed in the intestines of a healthy man each twenty-four hours, would be quite sufficient to kill, if it was all absorbed. He proposes the term stercoræmia for that condition which results from arrest of excretion from the intestines.

It is more than probable that the poisons of the intestines are due to the bacteria which are normally present; but this would not exclude the fever of non-elimination from the list of autogenous diseases. The bacterial cells, which are normally present in the intestines, cannot be regarded as invaders from without.

It would seem from some recent studies, that not all surgical fevers are due to bacterial activity. The absorption of aseptic blood clots, and of disintegrated tissue in cases of complicated fractures and contusions of the joints, is accompanied by an elevation of the temperature above normal. A like result may follow the intravenous injection of a sterile solution of hæmoglobin, or of the blood of another animal. The causative agent in the production of these fevers remains unknown. In the blood of twelve out of fifteen patients with aseptic fever, at the clinic of Nothnagel, Hammerschlag has found free fibrin-ferment, but in five persons without fever he found the same substance in the blood. This leaves the causative agent in the production of the aseptic, or, more properly speaking, the non-bacterial, fevers unknown.

The chemical theory of so-called uræmia has received support in recent researches, notwithstanding the fact that the old idea that urea is the active poison, and the theory of Frereiches, that ammonium carbonate is the active agent, have been abandoned. Landois laid bare the surface of the brain in dogs and rabbits, and sprinkled the motor area with kreatin, kreatinin and other constituents of the urine.

Urea, ammonium carbonate, sodium chloride and potassium chloride had but slight effect, but kreatin, kreatinin and acid sodium phosphate caused clonic convulsions on the opposite side of the body, which later became bilateral. The convulsions continued at intervals for from two to three days, when, growing gradually weaker, they disappeared. Landois concludes that chorea gravidorum is a forerunner of eclampsia. These experiments have been confirmed by Leubuscher and Zeichen.

Falck injected into both sound and nephrotomized animals fresh urine, urine and the ferment of Musculus and Lea, and urine which had undergone spontaneous decomposition, without producing any symptoms which were comparable with those observed in uræmia. However, he did find that, if a few drops of an infusion of putrid flesh was added to the urine before injection, all the typical symptoms of uræmia were induced. That the infusion of putrid flesh alone had no effect, was also demonstrated. This would lead us to believe that some ferment in the infusion converts some constituent of the urine into a highly poisonous body. In this connection, attention may be called to the fact that kreatin may be converted, by the action of certain germs, into methyl-guanidin, which produces convulsions. Whether such conversion occurs in uræmia or not, and if it does what the cause of it is, are questions which must be left for future investigations to decide. It would be well for some one to test the brain and blood of a person who has died in uræmic convulsions for methyl-guanidin.—*Journal of the American Medical Association.*

BACTERIA AND THEIR RELATIONS TO CERTAIN DISEASES.[*]

BY CHARLES SETH EVANS,

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Bacteria, micro-organisms and germs are synonyms for a large family of extremely small, microscopical organisms. They belong, undoubtedly, to the vegetable kingdom, where they occupy the lowest position.

Structurally they are cells, and consist of a cell wall, said to contain cellulose, and cell contents; a nucleus is not known to exist, though certain varieties of bacteria do, under favorable circumstances, develop in the cell contents a body which possesses certain points of analogy to a nucleus.

Micro-organisms abound in nature; countless myriads of them are to be found wherever there is animal or vegetable life, or decay. We ourselves swarm with them, our skins are alive, our intestinal tracts, with the exception of the stomach, and this exception has its exceptions, seems to contain more germs than anything else. And, in all probability, they are not such infrequent guests of our tissues.

The work they do and the part they play in the economy of nature should not be underrated. As a class, they do us much more good than harm. They are the tireless workers in Nature's laboratory, without which we, and all animal and vegetable life, would die; for they alone prepare the food for the plant life, on which all animal life ultimately depends. They, the simplest of plant life, possess the peculiar property of not only being able to live on the higher forms of both animal and vegetable life, but in so doing to decompose their complex structures into such simpler compounds and elements as may, in their turn, serve as food for higher plants.

As to the classification of germs, it has been found convenient to divide them into:

First. Molds (Schimmelpilze), or Hypomycetes.

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[*]Read before the Alumni Association of Niagara University. April 14, 1891.

Second. Yeasts (Hefepilze), or Blastomycetes.

Third. Bacteria (Spaltpilze), Schizomycetes.

It is with the third class, the bacteria or schizomycetes, that we, as physicians, not botanists, have the most to do, and which possess for us the most interest. One word in general: we do not admit that spontaneous generation can occur; we also hold that the various varieties of bacteria are distinct.

In classifying bacteria the first and most natural system is that based on form. It gives us, *first*, the bacillus, or rod-shaped cell; *second*, the coccus, or ball; *third*, the spirillum, or screw-shaped—forms, which have been compared to a billiard cue, a ball and a corkscrew. It must be remembered that a bacillus is really a cylinder, and not a line; that a coccus is really a sphere, and not flat like a griddle cake; and a spirillum is but a twisted cylinder.

As to whether the bacteria live on dead or live substances, we divide them into saprophytes and parasites. Of the parasites it has been found convenient to make two classes; the one which cannot live and multiply outside of the animal body is called obligatory parasites; the other, which, under favorable circumstances, can adapt itself to a life either within or outside of the animal body, we know as facultative parasites.

Disease-producing bacteria are known as pathogenic; that they may act in either a septic (toxic) or infectious manner has long been supposed, but is now definitely known.

Bacteria multiply by fission with the most surprising rapidity. Fluegge observed complete division in cocci in twenty minutes; and Cohn estimated that, did it take an hour for complete division and for the new cells to attain maturity, one coccus would, at the end of the first day, have produced sixteen and a half millions; at the end of the second day, two hundred and eighty-one billions; at the end of the third day, forty-seven trillions; at the end of the fifth day the number would be so great that all the oceans of the globe, did they have a uniform depth of one mile, would be filled.

Bacilli also germinate by means of sporulation; this process is not known to occur in the cocci and spirilli. By it we mean the formation of small, more or less round, highly refracting bodies in the bacilli. They are probably to be regarded as the seed of the plant; certainly like grains of wheat they retain the power of germination an almost indefinite period. What interests us most is the part these bacteria play, and how they play it, in the causation of disease.

We can imagine three possibilities:

First. By appropriating, for their own growth, sufficient nutrient material to starve the tissues.

Second. By their large number mechanically blocking the vessels.

Third. By producing in the process of development, from the complex albuminoids in which they live, other and toxic substances, which, becoming absorbed, act on the general system.

It is especially the latter view to which we are leaning more and more, and already a long list of these so-called ptomaines, or toxalbumins, have been isolated, some of which we know as *tetanine, cadavarine, neurine, muscarine, mytholotoxine, tyrotoxicon.*

Recent experiments have settled beyond a doubt that not only the systemic effects of certain bacteria are due to the ptomaines they generate, but that the local effects are likewise dependent upon the same cause.

And still more recent experiments have shown that acquired immunity, and immunity due to inoculation with attenuated cultures, are intimately associated with the same substances.

Other investigators have demonstrated that bacteria, even pathogenic ones, are not such infrequent inhabitants of the normal tissues. As to how these bacteria are disposed of—for they, like those introduced by inoculation, soon disappear, and need not produce any symptoms, much less the disease of which they may be the cause—the theory of Metschnikoff, or phagocytosis, has found rapid and widespread approbation. According to it, the leucocytes, and cells of the adenoid tissue possess the peculiar property of ingesting and digesting bacteria. Thus, it would seem, there is a constant fight going on between the phagocytes and the bacteria. If the bacteria are overcome, devoured by their enemies, the tissues continue in a healthy state; if the bacteria are victorious, then disease results.

The probability is that the leucocytes play the part of buriers of the dead rather than soldiers ; and, should a live bacterium be swallowed by mistake, the life of the cell pays the forfeit.

The more probable explanation is that of Petruschky, who has shown that the normal blood serum, deprived of all white cells, possesses the property of killing bacteria in limited number; that those animals which are congenitally immune to certain diseases, such as white mice and rats to anthrax, have a blood serum which possesses this property in a marked degree. He has further shown that these animals and others, such as rabbits to the staphylococcus albus, may be rendered temporarily susceptible by altering the character of their blood serum ; thus, white mice and rats lose their immunity to anthrax when the alkalinity of their blood serum is diminished, and rabbits become susceptible to the staphylococcus albus when a condition of diabetes is induced.

Bacteria, according to Wyssokowitsch, are not eliminated by the secretory organs.

In the production of disease by bacteria, much depends not alone on the specific character of the germs, but on their individual virulency, on their unmber and on their position in the tissues, as well as on the resistance which the tissues offer ; on the temperature and on the barometer.

Thus, Watson Cheyne found that in rabbits, to produce a rapidly fatal result, he must inject about one billion pus cocci, while two hundred and fifty millions caused only a small abscess. With the tetanus bacillus, also on rabbits, one thousand were necessary to produce death.

As to the virulence of the bacteria, the well-known experiments of Pasteur have familiarized us with the attenuated viruses or vaccines. We know, further, that, in the abnormal, hot-house growth which we obtain of bacteria in our culture media, a diminution in the virulence is far from uncommon, also that various physical conditions as well as the chemical composition of the media may bring about this result, but it is only of late that we are beginning to understand why this is so. That it is due to the formation of toxalbumins, ptomaines, which so modify the growth as to, more or less completely, cause the pathogenic variety to once more assume the harmless habits of the saphrophyte, from which it must at some time or other have departed.

As to position in the tissues, those floating in the blood do less harm than those lodged in the tissues.

The effects of inflammation of a low grade have been shown by Max Schueller, and very recently by Watson Cheyne. They, after inoculating animals with tubercle bacilli, produced slight subcutaneous injuries, such as contusions and sprains, and found that localization generally occurred at the injured part.

Rosenberg, Hocker, Becker, Kraemer and Cheyne obtained about the same result in producing acute osteomyelitis with the pus formers.

THE RELATION OF BACTERIA TO THE FORMATION OF PUS.

The mycotic origin of pus was definitely settled by Ogsten in 1881, though Klebs, years before, had come to the same conclusion.

To-day we recognize as pus formers:

First. Staphylococcus pyogenes aureus.
Second. Staphylococcus pyogenes albus.
Third. Staphylococcus pyogenes citreus.
Fourth. Streptococcus pyogenes.
Fifth. Bacillus pyogenes fetidus.
Sixth. Gonococcus of Neisser.
Seventh. Micrococcus tetragenus.

And as rarer forms the *staphylococcus pyogenes cereus albus* and *cereus flavus,* and *staphylococcus pyogenes flavescens.* By some observers the *bacillus pyocyaneus* is also regarded as a pus former.

The *bacillus tuberculosis* does *not* belong to this class. Of these, by far the most frequently met with are the *staphylococci aureus* and *albus,* the *streptococcus pyogenes* and the *gonococcus.*

The question immediately arises: Can the formation of pus be caused by other substances than the foregoing micro-organisms?

There seems to be but two possible ways in which this might occur; either from other micro-organisms as yet unknown or not settled as having this pus-forming property or from chemicals.

That pus may be formed by chemical action on the tissues has been determined: thus, croton oil, metallic mercury or turpentine, rendered sterile, placed in sterilized glass tears, and these by an aseptic operation made to heal in under the skin of animals, will there remain inactive as long as the tear is unbroken; but, however, on breaking the tear, pus is formed, in small quantities it is true, yet, chemically and microscopically, pus. Clinically, this pus can hardly be said to occur, for it is a sterile pus, does not contain a single micro-organism, and does not tend to invade the tissues.

Grawitz and de Bary have gone one step further, and have produced pus by the subcutaneous application of the toxalbumins derived from the pus formers themselves. The ptomaines were obtained from pure cultures and rendered perfectly sterile.

This, of course, is but another example of chemical irritants producing pus, but is of much more significance than the action of croton oil, for it explains how the pus formers do their work. The micro-organisms generate the ptomaines, and the ptomaines by their chemical action on the tissues cause the formation of the pus.

That the micro-organisms are the true and specific cause of suppuration, is proven beyond a doubt. The chain of evidence is complete. All infectious pus contains bacteria which have been cultivated, through many generations, outside the body, in pure cultures, and on inoculation with these pure cultures pus has again been formed, and the same germs found in the pus so formed.

On man these inoculations have been performed by Garre, who rubbed a quantity of a pure culture of the staphylococcus aureus into the skin of his forearm and it took weeks for the resulting carbuncle to heal.

Some inoculation experiments have failed, owing to some error in the technique, using too small a number of germs, or those which from abnormal conditions in which they are grown outside the body, had lost their virulence.

At other times abscesses have been found which contained none of the pus formers. These are almost invariably "tubercular abscesses"; when not, it is highly probable that a portion of the pus was selected in which all the germs had died—killed by their own secretions.

As a rule, the infections due to the *streptococcus pyogenes* are more serious than those due to the *staphylococcus*. This is probably because the former tends to spread along the lymph spaces, to involve more area and show less tendency to become limited.

RELATIONS OF BACTERIA TO DIPHTHERIA.

Lœffler found in the membrane of diphtheria, but absent in the blood and tissues, a bacillus. This bacillus, he maintained, occurred regularly in every case of diphtheria, and this statement has been substantiated by Babes, Kolisko, Paltauf and others.

Loeffler himself was very reserved about declaring his bacillus as the specific cause of diphtheria, but more recent experiments by Roux and Yersin have settled the question definitely; so that we may now regard the bacillus of Lœffler as the true cause of diphtheria in man.

The bacilli have about the average length of tubercle bacilli, but are nearly twice as broad. The form, however, is subject to variations, such as thickening of one end, transverse markings, etc.

Lœffler's bacillus does not form spores.

Cultures obtained from diptheritic membranes do not, at first, grow well on our culture media, but seem in the course of three or four generations to become accustomed to their new food and then grow luxuriantly, though they at the same time lose their virulence.

Inoculation experiments on man have not as yet been made. On animals they soon developed the fact that not a few species possess immunity. Mice and rats will not become infected, while most birds, especially pigeons and chickens, and usually rabbits and guinea pigs, are susceptible.

On rabbits the inoculation experiments are especially interesting. They are ill for days and even weeks, thus giving time for the development of the general symptoms, the occurrence of paralysis.

The purely local occurrence of the bacilli and the severe general symptoms are best explained on the hypothesis that the bacilli, in their growth, generate a soluble substance capable of producing the systemic disturbance.

Roux and Yersin found that the sterile filtrate made from pure cultures which were not too young, possessed the power of producing in animals, when injected subcutaneously or into the blood current, the same symptoms as do inculations with pure cultures. No membrane occurs on the mucous surfaces, but the paralyses do occur and are usually fatal.

The larger the dose the more rapidly death ensues, but, when small doses are employed, then the paralyses follow only after the lapse of many days or even weeks.

The diphtheria ptomaine is a modified albumin derived from the normal albumin of the tissues. It must, however, be noted that, clinically, the bacilli of diphtheria never occur alone, but are almost invariably associated with *streptococci*. This mixed infection is certainly important, and many observers maintain that especially fatal cases owe their virulence to the associated micro-organisms.—*Buffalo Medical and Surgical Journal.*

SCIENTIFIC GLEANINGS.

SYMBIOSIS.

BY T. H. PAMMEL, B. A.

There are few subjects of more general interest than that of symbiosis. Originally the term was used where two organisms were associated together, but, as now understood, it means "the association of plants with plants, or plants with animals, in such a way that the relation between them is one of mutual benefit, or in which there is at least no injurious action of one organism on the other."* Cases of symbiosis in the vegetable kingdom have been known for some time. Lichens afford an excellent illustration. Here the plant body or thallus consists of two organisms, a fungus and an alga known as gonidia. The fungus grows around the cells of the alga, and a close relation is formed between the two. The fungus supplies mineral matter to the alga, while it also promotes assimilative activity of the alga. Without the alga the fungus cannot live, at least for any great length of time, since it is devoid of any of the green coloring matter, chlorophyl.

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*Dr. Farlow, Vegetable Parasites and Evolution, Bot. Gazette, vol. 7, p. 173.

In recent years the subject of symbiosis has received considerable attention, owing to the bearing the question has upon a rational agriculture. It has been known for a long time that leguminous plants, like clover, enrich the soil. This led to the very general belief that these plants have the power of taking up the nitrogen of the atmosphere by their leaves. Leguminous plants invariably left more nitrogen in the soil, while plants like wheat left the soil poorer in this very important element.

Boussingault, who made some very careful experiments as to how plants obtain their nitrogen, came to the conclusion that plants do not take up any of the free nitrogen from the atmosphere through their leaves, although there was an appreciable gain of nitrogen over that found in the seed. Dietzell, who experimented in this direction, came to the conclusion that clover and peas cannot appropriate the nitrogen of the atmosphere by the leaves or other parts of the plant above ground. Wolf and Kreuzhage, however, were able to show that leguminous plants grew just as vigorously in a soil free from nitrogenas in one containing an abundance of this element, the plants appropriating a very considerable amount of nitrogen. Other investigators obtained similar results. Since it was demonstrated that parts of the plant above ground could not appropriate free or combined nitrogen, scientists endeavored to find "helping" organs which would assist in this. They have been discovered in the small tubercles found on a large number of leguminous plants. The peculiar tubercle-like swellings found on the plants of this family vary much in size. The smallest are not larger than the size of a pinhead, while the larger are as large as a hazel-nut. They were observed as early as 1687 by Malpighi, who supposed them to be galls. De Candolle thought them diseased structures, while Treviranus held them to be undeveloped buds. Woronin, who studied these structures very carefully, considered them diseased structures, as he found small organisms in them. Cornu likewise considered them diseased structures which were first invaded by nematode worms. Eriksson, who made a very careful study of these tubercles, noticed that the organisms found by Woronin were not simple rod-like bodies, but were frequently forked. He also noticed thread-like bodies extending from the outer part of the tubercle radially inward. These are readily seen, and have been observed by nearly all investigators who have given the subject any attention. Frank, in some of the earlier papers on the subject, called attention to the non-appearance of these swellings in soil which was sterilized. Brunchorst and Tschirch considered the tubercles to be normal structures, and that they arose from the protoplasm of the cells. The small gemmules found in the cells were called *bacterioids.* The authors did not regard them of a fungus nature. These bacterioids were regarded as reserve material, which later were absorbed by the plant, especially during the formation of seed. Marshall Ward, in a very excellent paper, in which the results of his experiments with the common Windsor Bean (*Vicia Faba*) are given, concludes that the tubercles develop invariably in soil when it is not previously sterilized. They do not develop when the soil is sterilized. That the fungus enters the plant through the root-hairs, forming a thread-like body. That in the interior of the cell the organism multiplies.

Beyerink, Wigand, and others, have cultivated the organism originally from the tubercles in nutrient media such as gelatine. Leguminous plants inoculated with these produced typical tubercles. Beyerink called the organisms *bacillus radiciola.* Earlier the tubercles were called *schinzia leguminosarum.* Frank has recently given it the name of *rhozobium leguminosarum.*

All the more recent investigations indicate that the organisms enter by way of root-hairs; that the organism is widely distributed in the soil, and Frank states that the root hairs throw off a nutrient substance which draws the fungus to it, and thus enables it to multiply on the surface. A few of these bacteria enter the root hair and form little clusters at the tip ; these become enveloped with a glistening membrane, which is firmly united to the cell wall. Thus a knob is formed at the tip of the root hair from which arises a threadlike body that proceeds inwardly. Frank is of the opinion that this threadlike body is probably a production of the cell wall and forms a passage way for the bacteria to pass down to the deeper tissues of the root. Here the protoplasm or the cell becomes intimately associated with that of the organism. So that the protoplasm of the cell is a mixture of the two which Frank has called *mycoplasma.* From the root the organism is distributed to various parts of the plant, even to the fruit. Frank states that it has even been found in the embryo, so that the organism may be transmitted to future generations. At the points of the root where the organism entered the tissues, new cells are formed, finally developing into the tissues of the root. Frank still retains the term *bacterioids* for the bacteria-like bodies found in the tubercle. According to his notions the cocci are imbedded in the protein elements.

The chemical researches made by Hellriegel and Wilfarth, Atwater, and others, indicate that these tubercles are important in the acquisition of nitrogen.

Hellriegel and Wilfarth draw the following conclusions from their elaborate experiments : "That leguminosæ behave quite differently from grasses with respect to the appropriation of nitrogen. Grasses depend entirely for their nitrogen on the nitrogen compounds contained in the soil. Leguminosæ can, in addition to the combined nitrogen of the soil, appropriate the free nitrogen of the atmosphere. They cannot assimilate the free nitrogen without the aid of the micro-organism in the tubercles. It is not the mere presence of these organisms which enables plants like clover to assimilate free nitrogen, but the latter must be in a symbiotic relation. That the root tubercles of leguminous plants are not simply storehouses for the proteid substances." Atwater states the case as follows : "Without root tubercles there was in no case any large gain, and with them there was uniformly more or less gain of nitrogen from the air. As a rule, the greater the abundance of root tubercles in these experiments the larger and more vigorous were the plants, and the greater was the amount of atmospheric nitrogen acquired."—*The Vis Medicator.*

(*To be continued.*)

HEREDITY: ITS PART IN ORGANIC EVOLUTION.

BY PROF. HENRY L. OSBORN, HAMLINE, MINN.

By heredity is meant the transmission to its offspring by a parent of the power to grow into the parental image. Of the fact of heredity in some sense of the word there can be no doubt whatever. It is easy enough to demonstrate beyond any dispute that young animals grow into the likeness of their parents in virtue of the operation of some internal force which guides them in that direction. Thus, for example, the eggs of two species of echinoderms will develop in the same glass of sea water where the surrounding influences, external to themselves, must be the same for each, and yet each follows with unerring step a predetermined path. Eggs of our domesticated fowls can be placed under the same conditions, as in an artificial incubator, or intrusted to that wonderful instinct resident in the natural incubator, but their similitude of environment does not turn the embryos aside from their predestined course. I have lately been watching the eggs of the salamander, and they are such delicate and helpless things that one would hardly think such feeble folk could be so true, and yet day by day they follow courses exactly similar to those gone through in their growth by similar or identical European forms and recorded by Von Baer as long ago as 1834. Such facts as these show that the environment does not produce the mature animal, but that the egg from its start contains a force which propels it in a definite direction and which we call heredity. The fact that a delicate bit of protoplasm, the egg-cell, can hold its own among the contending forces in whose focus it is placed is the greatest miracle of nature.

But we must carefully remember that when we have referred the resemblance of a child to its parent to heredity as its cause that we have not really answered any question regarding the *vera causa* of the resemblance ; for we have only given the inquirer a word, a name, and not anything more. Heredity, in fact, is one of the fundamental properties of protoplasm which no one has as yet succeeded in reducing to simpler terms. We say, if we use the language of Professor Huxley, that living things are unique among other things in undergoing "cyclical changes." Having noted what we mean by heredity, we must note in the second place that animals at large present grades of resemblance less close perhaps than that customarily observed between parent and offspring, and yet a structural resemblance which has not escaped observers from a very early date in the history of nature study. Attempts at classification of animals or plants are based upon these resemblances. At first the question into the meaning of these resemblances was not thought of, but later it arose and has been answered in only two ways. By one school of philosophical biologists the resemblances were understood as indications that the animals were as one might not irreverently say made to order, and made by varying a few patterns a little this way or that. This conception was that which Prof. Louis Agassiz ably defended in his essay on classification. Its failure to account for many of the facts of embryology and comparative anatomy led it to be rejected by most biologists. By the other school of biologists the resemblances were understood to indicate more or less remote actual genetic relationship or kinship between animals presenting them. Thus the red and grey squirrels by the Agassizian school resemble each other more than either does the gopher, merely because they were made by their maker as modification of one plan in his mind, while their resemblance appears to the other school to indicate a comparatively close actual kinship.

The latter conception is the Darwinian view ; it extends the operation of descent, which is a natural phenomenon, never having been called in question by any thinkers so long as its operation is confined to the relationship in one "species," to the entire range of animals and plants. The Darwinian view of the meaning of classification, then, is that resemblances between living things really indicate, as they seem to, a kinship. Heredity is thus a conservative factor if its range is thus extended and tends to keep animals alike down to very remote generations. Heredity may then account for the likeness among animals widely remote in their relationship, as, for instance, fishes, reptiles, birds and mammals; but, as we have considered it thus far, will it account for their differences? We may note in the third place that the differences between animals might conceivably be due to the interaction between the inherent and hereditary tendency and the environment of the animal. The French zoologist Lamark was acute enough to think of this, and he proposed to explain the order of the animal and plant worlds upon the two assumptions that the use of organs modifies their structure, and that parents transmit this modification of structure as well as their general race type of structure. His theory attracted but little attention at the time. Unfortunately for Lamark's theory there are very few facts which go to prove that modifications of structure acquired during the lifetime of an individual can be transmitted by heredity. Modifications of structure which appear "congenitally," as it is termed, that is, those which are, so to speak, born in an individual so that they are independent of the animal's environment, are well known to be transmissible. Thus, for example, a cat born tail-less or six-toed would be likely to transmit the peculiarity to its offspring, but one who had lost a tail or gained a toe by accident during adult life would be almost certain not to transmit the peculiarity. Lamark's proposition is, therefore, not obviously true to facts.

Before going further, I may now call attention to the importance for clearness of distinguishing modifications of structure which have been the direct result of the use of organs called acquired characters and modifications, which have appeared in an individual independently of use, such as monstrosities for instance, or sports among plants, as well as hundreds of slight and hence unnoticed ones which are called "congenital variations." Heredity is admitted by about all writers to include the parental type and any congenital variations.

Darwin, in his theory of organic evolution, sought to account for the varied forms of animals and plants as the outcome of transmission of race type and congenital variations with the supplementary effect of crowding, which would cause a natural selection of the best for breeding, the poorest having succumbed in the contest for life. This theory left too much to the element of chance in accounting for the appearance of favorable congenital variations at the critical time, and Prof. E. D. Cope, whose studies had been chiefly among the osteological features of vertebrates, proposed to supplement Darwin's hypotheses of the "survival of the fittest" by accounting for the "origin of the fittest." He revived the Lamarkian view that the acquired characters are transmissible, and considers it the chief factor in organic evolution. An extension of Darwin's view was seen to be necessary by its astute author, and he repeatedly stated, in language now seized upon by Cope and his compeers, that he only called the variations naturally selected on the terms of his theory "chance variations," because he did not know how they were produced, and that acquired characters might to some slight extent be transmissible. Darwin's view presents an immense advantage over its former rival, the view of the elder Agassiz, in the way it harmonizes a vast body of biological data in all departments, no rational interpretation of which has, so far as I know, ever been attempted upon the other view.

The hypothesis of evolution can hardly be said to have gotten upon any very solid advance ground since Darwin left it. It is now much better understood and its main features accepted by nearly all biologists. But two violently hostile schools have grown out of the effort to deal with the cause of diversity among living things. One school, the Darwinian, numbers Lankester and Weismann among its leaders and insists that no "acquired characters" are proven to be transmitted; and so far as facts have been positively gathered it must be confessed that they are in their favor. The "Neo-Lamarkians" do not, however, give up the fight, and in spite of their inability to produce any actual, indisputable cases of the transmission of acquired characters, they collect the evidence from lives of creatures apparently evolved and find no adequate explanation of the progression of structure they exhibit, except on the assumption that function so reacts on the organism, though in an unexplained way, as to add to the sum of tendencies to be transmitted the tendency to inherit the acquired structure. The question thus becomes really an inquiry into the nature of heredity. My statement of the case at the beginning of this article is intentionally vague, for it leaves undefined the term "parental image." The progress of the article, I think, shows that we cannot yet say what this transmissible image is. How far is it the race type, how far the individual image? Is it the image of the ever-changing parent at the instance of the egg's first start on its course to independence or at some previous time? Is it a partial product of the diverse tendencies of both parents? Not one of these questions can be answered. While thus the general proposition of evolution as the result of survival of the fittest is virtually settled the further question of the origin of the fittest still awaits solution.—*American Microscopical Journal.*

PROF. R. KOCH ON BACTERIOLOGICAL RESEARCH.

In an address on bacteriological research, Prof. R. Koch gives a rapid sketch of the history of bacteriology, the age of which is computed to be about fifteen years. After acknowledging that our present knowledge is in great measure due to, and in fact has been rendered possible by, the great improvements in microscope objectives and in the methods of technique (preparation, preservation, cultivation, etc.), the author lays it down as being incontrovertible that all species of bacteria are constant, but admits that within certain limits they may deviate from the normal type, the pathogenic being most prone to variability. The confusion which has frequently arisen with regard to the species of bacteria is ascribed to the undue prominence given by some writers to certain characteristics, and it is held by the author that the proper method of determining the specific position of micro-organisms is to very carefully consider every characteristic, morphological and biological. And even when this has been done there are numerous difficulties to be overcome; for example, to isolate and identify the typhoid bacillus from the contents of the intestine, from the soil or water, is difficult even for the experienced observer. Yet with a few bacteria more certainty can be attained; cholera vibrios and tubercle bacilli possess specific characteristics by which they can be easily identified. But even in the case of tubercle bacilli a caution is necessary, for the author notes that the bacillus of fowl tuberculosis is obviously a distinct though closely allied species.

The next point discussed is the relation of bacteria to disease. The proof of a direct relation is perfectly clear with regard to a certain number of infectious diseases—anthrax, tuberculosis, erysipelas, etc. And as to some others, such as typhoid, cholera, diphtheria, relapsing fever, leprosy, there is little doubt, although the attempts at artificial infection have hitherto failed.

After alluding to the importance of the metabolic products of bacteria and the recently discovered toxalbumins, the author expresses his opinion that the question of immunity can only be answered by the aid of bacteriology, and then passes on to consider some of the biological phenomena of bacteria.

After this the numerous failures of bacteriology are touched on, as in measles, scarlet fever, typhus, small-pox, rabies, influenza, and numerous other infectious disorders.

The address concludes with a consideration of the methods at our disposal for combating pathogenic micro-organisms, either directly, as by disinfection, or indirectly, by the application of certain substances to the body which might render the bacteria inert without injury to the organism.—*Jour. R. M. S. Microscopical Bulletin.*

PHAGOCYTOSIS AND IMMUNITY.

The fact that one attack of a contagious malady, such as small-pox, or scarlet fever, renders an individual immune against a second attack has never received adequate explanation. It is even more difficult to explain satisfactorily the immunity conferred on an animal by inoculating it with the attenuated virus of a disease which in its ordinary form is often, and in a few cases invariably, fatal, such, for instance, as protective inoculation for anthrax, chicken cholera, and the older method of vaccination to protect from or modify an attack of small-pox (*The British Medical Journal*). In a lecture recently delivered by Dr. Metschnikoff at the Pasteur Institute, an attempt is made to prove that the defending powers exercised by the amœboid cells of the organism are in a large measure concerned in conferring this immunity. The aggressive characters of these amœboid cells has earned for them the name of "phagocytes," and Metschnikoff points out that they are of different kinds, and originate in various ways. In connection with the subject of immunity, it is important to remember that these phagocytes can include and destroy micro-organisms; but the more malignant the micro-organisms the more rarely is it found within the phagocyte, and this is especially true of such diseases as chicken cholera, hog cholera given to pigeons and rabbits, and anthrax of mice. All these diseases have the character of general acute septicæmia and cause death within twenty or thirty-six hours. According to the views expressed in this lecture, we are to believe that, when the micro-organisms are attacked by the phagocytes, an animal may recover from the disease. In the malignant forms, where the phagocytes do not intervene—that is, phagocytosis or amœbic warfare is not established—then the bacteria overrun the organism, and induce death. This partiality of the phagocytes is attributed to their sensitiveness to external influences, and especially to the chemical composition of their environment. These cells are powerfully attracted by many micro-organisms, and repelled by others. This attraction and repulsion are expressed by the terms "positive chemiotaxis" and "negative chemiotaxis." Now the basis of the theory appears to be that the chemiotaxis of the phagocytes of a given animal is mutable, and that cells may be gradually attracted to substances in a mild form from which they shrink when presented to them in a concentrated form. Hence by inoculating an animal with an attenuated virus the chemiotaxis, previously negative, will acquire positive characters, and at last be induced to attack the micro-organism of a malignant disease, should occasion arise. Any attempt to explain immunity from infectious diseases on a rational basis will be very welcome. The theory propounded by Metschnikoff, is, like all the previous communications made by him on the subject of intracellular digestion, the outcome of patient and industrious observation, and must command our attention. His views, formulated for the first time in a consecutive manner in this lecture, promise to revolutionize opinions as to inflammation and fever, and this attempt to explain the power of the cells to confer immunity from infectious diseases is sure to be hotly contested ; for every important contribution to this confessedly obscure subject must necessarily be in a large measure hypothetically.—*Medical & Surgical Reporter.*

MISCELLANEOUS.

*A MICROBIC CATASTROPHE.**

BY MIKE ROBY.

THE CONSEQUENCES OF TOO MUCH STUDY IN BACTERIOLOGY.

The car was well filled as we rolled out of the depot at Jersey City, but rapidly thinned out until we reached Elizabeth, beyond which there remained but two passengers besides myself. For some time I remained buried in thought, recalling the scenes of the day and (I must acknowledge it) endeavoring to fix in my memory some of the good things said during the evening, that they might help me out on some future occasion of the same sort. Presently my attention was attracted to my two fellow passengers, who, by a succession of smothered snorts, and now and then an irrepressible roar of laughter, seemed to have something very funny with which to regale themselves. They appeared to be two dealers from some village in the western part of Pennsylvania, who had been to the metropolis for their semi-annual stock. By degrees I made out the subject of their merriment. It seems that in their vicinity was what they

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*From the *Medical Times and Register*.—Annals of Hygiene.

called a tamarack swamp. This must be something like a quicksand, for whatever goes into it is swallowed up and is seen no more. Popular tradition considers it a bottomless pit, or at least locates the lower extremity of the swamp in a very hot climate. It has been used by the surrounding country people as a convenient dumping ground for refuse of all sorts from time immemorial. Quite recently a newly-chartered railroad had surveyed its route directly across the swamp, and directed the contractor to fill it up. But this was easier said than done. The engineer made his estimates, and the full quantity of earth was thrown into the swamp, but it was not filled up. Another requisition was made and filled; the gulf yawned hungrily as at the beginning. The track could very easily have been laid around the swamp at no additional expense; but with true corporate obstinacy the company had got its back up, and determined that across that swamp their road must go, and directed the engineers to proceed with the filling until the work was completed. The force upon duty was doubled, and the work pushed ahead with vigor. Several times they thought they had succeeded, and a firm roadbed was formed and track laid, but the next morning it had disappeared beneath the dark waters of the swamp. Five thousand carloads of rubbish had been emptied into the abyss, and the task seemed as far from completion as when first begun. The attention of the whole neighborhood was drawn to this novel contest between the railroad and the tamarack swamp. The result was vastly amusing to the country people, who, as a matter of course, took sides with the swamp against the corporation, and an immense amount of chuckling and self-felicitation took place as their predictions that the bottom of the swamp would never be reached seemed daily more likely to be verified.

My fellow-travelers finally quieted down, and my thoughts recurred to the principal topic of the evening. If the balance created by nature were disturbed, and the process of reproduction allowed to proceed without any obstacle, and the death of the progeny were suspended, how many microbes would there be in a week, and would Allegheny county hold them? At this point, whether lost in the immensity of my conceptions or whether the stimulating effects of the wine had evaporated I know not, but I fell asleep.

How long I had slept I cannot tell, but I was awakened by a sensation of cold. It was some time before I could recollect where I was, and when I did my bewilderment was scarcely lessened I had fallen asleep in an ordinary parlor car, but the one which I was in did not resemble it in the least. The richly upholstered couches and the beautiful woodwork had disappeared. I was lying on a lounge so thickly wrapped in furs that I could scarcely move. My feet were in close proximity to a stove which occupied the center of the car. Roof, floor and sides were thickly hung with furs, which seemed to press down upon me with smothering force. One small window of thick but beautifully transparent glass remained, and the draught from this seemed to chill the marrow of my bones. Glancing through it I could see that we were going at a fearful rate. Huge shapeless masses shot by like meteors. The country through which we were passing was a waste of ice and snow. No sign of human life was visible; not a tree or bush enlivened the landscape. Chaotic masses of rock broke through the snowy covering of the plains, but rather added to than detracted from the desolation of the scene. In the distance the majestic forms of great icebergs sailed by, slowly, yet withal swiftly enough to show at what a terrific rate we were traveling. Through all this desolation it was somewhat reassuring to see the moon looking quietly down upon me—looking just as she always did, but brighter than I had ever noticed her before. But—what! Surely I went to sleep in Jersey, and here is the Pole Star almost directly over my head!

While cogitating on what this new phenomena might signify, the door of the car suddenly flew open, and with a freezing blast in staggered the most singular looking creature. He was a boy about ten years old, but so gaunt and withered that he looked like an old man. He was wrapped in many layers of ragged garments of somber hues. His head was covered by a tangled mass of uncombed locks, over which was tightly drawn a uniform cap. His grimy face bore the traces of tears, but these had ceased, and his large, dark eyes bore no expression but that of dull despair. He was passing mechanically through the car without seeming to notice me, when, feeling as if my brain would become unsettled if I could not get some conception of what all this meant, I stopped him.

"Who and what are you?" said I. He raised his eyes to meet with a momentary gleam of intelligence, and said, in a dull, listless voice," "I am the last newsboy, and here is the last newspaper." And so saying he laid down a paper on my lap and sank down on the floor in front of the fire. I looked at the paper. It was printed on a sheet of common whitey-brown wrapping paper, and from its general appearance it flashed upon my mind that it was the last despairing work of a man whose hand fell nerveless as the press made its last impression. There were no headings, no advertisements, no paragraphs. It was printed in one continuous form, and in fact looked more like a leaf torn from a book. It read as follows:

"The awful catastrophe which has come upon the world is so singular that even now, when the period of the higher forms of animate nature is about to be completed by their total extinction, we cannot help acknowledging that by no human forethought could the calamity have been avoided. It has been only during the present century that the existence of the minuter forms of life were discovered. Only during the last decade did the improvements in the microscope render the discoveries of Pasteur and Koch possible. And yet, when the scientific world had opened its eyes to the truth, the possibility of this frightful accident was lost in its overwhelming impossibility.

"To recapitulate facts which are now but too well known by all: Among the microbes recently discovered, whose sphere consists in bringing destruction upon higher organisms, the bacterium of glanders stood pre-eminent. It was the smallest of all. It multiplied with amazing rapidity. It gathered new intensity when allowed to work under favorable conditions, acquiring increased vigor with every development of new broods. If a full supply of material for growth could be obtained, and no injurious conditions existed, a single microbe would in two days be represented by two hundred and eighty-one trillions of its kind. But so remote was the chance of such conditions being ever presented that the imagination of Verne never compassed it. Nor would it have been presented had not an illiterate farmer in the West been impelled by sad fate to cast into the tamarack swamp the body of a horse which had died of glanders. So seemingly inconsequential was the act which destroyed the world! Here was a carcass containing billions of these microbes; and the swamp afforded a limitless matrix in which they could multiply without a single unfavorable condition. The decaying organic matter which had for ages formed and sunk into the swamp supplied the material for growth.

The result was quickly manifest. The men who were engaged in constructing a roadbed across the swamp found their labors unexpectedly brought to an end. The swamp was filled at last, the rails laid, and the directors in a special train rode over it in triumph. But that was the only train which ever passed over that fatal swamp. The next one ran off the track, and on examination the roadbed was found to be lifted up a foot above the level. The engineers were blamed and ordered to lower the tracks. But when the workmen came to do this they found the tracks several feet in the air, and in a week a lofty hill uplifted itself upon the site of the unlucky swamp. Nothing daunted, the mulish board ordered their men to tunnel the hill. One day, when an unusually large blast of dynamite had been exploded, the workmen found a new enemy to contend with. From every crack and crevice of the quaking tottering hill there oozed masses of a singular substance resembling the "mother" of a vinegar barrel. The hill rose higher daily until it overtopped the neighboring heights. The curious came from all sides to look at the wonder. The mother-like masses poured out until they covered the hill and commenced to descend upon the surrounding farms. People began to grow anxious concerning it, especially when a commission sent by the government announced the true nature of the phenomenon. The hill grew to a mountain, and down every ravine which rent its sides streamed rivers of slimy matter which spread over the plains below. Those who last ventured near enough to view the site of the fateful swamp saw a terrific sight. It was converted into a furious volcano which vomited forth, with momently increasing power, masses of vital, living beings, countless tons upon tons of microbes. Every obstacle was overcome in its course. Trees, rocks, rivers served but as food for the relentless creatures, whose powers were so greatly increased by unrestricted development that no object, animate or inanimate, could withstand their destructive attacks. Far and wide the floods of this new deluge rolled their unebbing tides. First the farms in the immediate vicinity were covered; then the whole country; then it rolled down the river, ever spreading, until the whole Ohio valley was overwhelmed. Many hoped that the flood would pour down the Mississippi and be lost in the Gulf. But this outlet was insufficient for the ever-increasing flood, and from every gap in the Alleghanies, nay, over every mountain top, it pours down towards the ocean. Faster and faster it spreads. America is lost. The Atlantic is thick with microbes; the world is gone; and the only question now left for humanity to settle is whether the all-conquering bacillus can withstand the cold of the Poles."

I dropped the paper from my palsied hands. The last traveler on the last train, I was flying North! Hurrying, skurrying, speeding North! * * * The foes gather for the onset. They form in one vast mass, piling up mountain high, coming with resistless force. Boreas is beaten back! The train stops. Over our heads the mass impends; it is on the brink of falling. It falls in avalanches, overwhelming us in its billows—the car is crushed—I

"Help! I'm smothering! Hello! Gosh!"

The last exclamation was called forth by a souse of ice water over my devoted head, which effectually recalled my senses to their proper habitat. I found myself floundering on the floor, vainly endeavoring to free myself from the superincumbent weight of an old and obese lady, who was making the welkin ring with her shrill screams. When quiet was restored I found that the aged party, who had boarded the train after I had fallen asleep, had visited the end of the car in search of a glass of ice water. Not finding it she had sent the porter to another car for her drink, and just as he was in the act of handing her the cup a sudden lurch of the car precipitated her upon my devoted form, overwhelming me at once.

In her fall she wildly clutched at the porter's arm, and hence the deluge of ice water on my head.

However, apologies were duly tendered, damages repaired, and by the time we rolled into Broad Street depot the ancient dame and I were firm friends.

After maturely deliberating upon the occurrence I have come to the conclusion that in something I had taken during the evening there was some of the specific bacteria of nightmare. [It was perhaps the germ of delirium tremens.—ED.]

WARDERS OF THE BLOOD.

WILLY NOBBE.

Ueber Land und Meer, Stuttgart, June.

Our body is composed approximately of thirty billion cells, the primary units of life. Not only are they the material particles out of which our organism is built, but they form the foundation for the functions of all our organs. What we commonly call life is nothing else than the sum of the functions of all the cells. The complicated mechanism of the human body exists and is kept in working order only by the intimate co-operation of a number of separate living beings far transcending our powers of conception. Yet each infinitesimal being lives in and for its individual self and not for the whole mechanism; it breathes, takes sustenance to itself, and gets rid of the used-up material. That such a cell is capable of life as a separate individual can be seen in the amœbas, those smallest of animalcules, which consist of nothing more than a mass of protoplasm inclosed in an extremely thin membrane, exactly like the cells of the human organism. An exceedingly interesting variety of these cells is what are called the leucocytes, the "chimney-sweeps of the blood," as a famous living physiologist has characterized them, which were known in the last century, but whose functions we do not entirely understand to this day. These leucocytes, which are of microscopic size, are present in the blood in the form of "white blood corpuscles," in the proportion of one to every three or four hundred red corpuscles. The proportion is entirely different in consumptives or persons suffering from leucocythemia, who harbor in their blood a great excess of the white corpuscles. This, and not, as many suppose, deficiency of blood, is the true cause of consumption. Leucocytes are found not only in the blood vessels, but also in the spleen, the liver, and many other organs. The construction of the white blood corpuscles is very simple. They consist of a soft, semi-fluid mass called protoplasm, which contains one or two nuclei, and the whole is surrounded by a fine membrane or cell wall. They are globular in shape and are larger than the red corpuscles, which have neither nucleus nor membrane. Their movements also are different from those of the red corpuscles, which shoot through the middle of the stream of blood, while the white roll along the walls of the blood vessel. Sometimes three or four are seen close together, and again they are found widely separated. Like the independent animalcules that have been mentioned, the amœbas, the leucocytes are able to change their shape at any time by forming pseudopods. A part of the mass contracts and throws out an irregular process, which in turn buds into a new one or several. These pseudopods serve the amœbas as a means of taking food and of locomotion, and they perform the same offices for the leucocytes. If these come to a narrow blood vessel, they elongate themselves and thus slip through, to resume afterward their original form. Besides their ability to change their shape, they possess another very remarkable property that shows what an important part they perform in the animal economy and has justly earned for them the name of "nomad cells." This is the power of leaving the blood vessels by breaking through their walls. When a leucocyte wants to migrate—the operation takes place in the finest and smallest of the blood vessels, the capillaries as they are called—it first throws out a kind of pseudopod, a filament of exceeding fineness, which bores its way through the tissue of the wall. When it reaches the outer side, minute granular particles of protoplasm are sent along the thin appendage, and these collect in a small bunch on the outside of the membrane. This process goes on until the entire leucocyte has passed over to the outer surface of the membrane, whence it pursues its journey into the interior, penetrating the tissues. This faculty, interesting and unique as it is, would not give the leucocytes such physiological importance if it was not supplemented by another equally interesting peculiar property. This consists in their ability to render innocuous any alien substance that has got into the blood vessels in any way. Whenever a leucocyte comes in contact with such a foreign body it seizes and holds it fast by throwing about it a pseudopod, and then gradually envelops and absorbs it. This is a fact that can be proved by experiment. If we introduce a foreign substance into the blood, for example, fine powdered indigo, we will find that in a comparatively short time, perhaps twenty-four hours, it will disappear entirely from the plasma. The leucocytes have taken it up, loaded themselves with it, as we can see from their altered color, and thus removed it from the blood. They thus cleanse the blood passages, sweep out every kind of refuse, and keep the road always clear for the ceaselessly pulsing vital stream. They will allow no poison as a destroyer of life to gain the mastery in the blood fluid. They will fight with it to the death, and ofttimes their valiant struggle is crowned with splendid success--a human life saved. If the forces of the enemy are stronger than they, still they will never give up the fight till the last of their band has fallen.—*Literary Digest*.

TECHNIQUE.

THE POLARISCOPE.

JOHN M. HOLZINGER, PH. D.

A stick thrust obliquely into a vessel appears abruptly broken at the point of contact with the water. A penny lying in an empty dish, and just concealed by the side of the dish from one looking obliquely into the bottom, will come into view if the dish be filled with water. Light travels in straight lines, but only so long as the medium is of uniform density, or so long as the light falls perpendicularly on media of different density. An oblique ray is bent from a perpendicular passing into a rarer medium; on passing to a denser medium, it is deflected toward that perpendicular. And the above well-known phenomena illustrate refraction.

Now, all the transparent substances met with in our experience, as water, air, glass, do thus deflect the rays of light. Some less common transparent solids, always crystalline, modify light in a more unusual way. If we could replace the water in the dish by Iceland spar, the penny would again appear above the edge, but it would now seem to be double. This mineral thus possesses the property of double refraction. The two rays, resulting from the splitting up of one, emerge from the crystal still more remarkably modified; both now are polarized, the one following the ordinary law of refraction being known as the ordinary ray, the other as the extraordinary. While the other waves of ordinary light are probably of various forms, principally circular, the waves of polarized light are in straight lines at right angles with the path of the ray, and lying in a plane or parallel plane. In case of the two rays resulting from double refraction the vibrations of the one are at right angles to those of the other.

Light is polarized also by reflection from smooth surfaces not metallic. The angle of incidence or polarizing angle varies for different reflecting substances. This is polarization by reflection; the other, polarization by refraction.

The most convenient and desirable form of polariscope for the microscopist consists of two Nicol prisms. A Nicol prism is a rhomb of Iceland spar cut by a diagonal plane and re-cemented with Canada balsam. The effect of this oblique stratum of balsam is to reflect to the side, and eliminate entirely the ordinary ray; so that only the extraordinary passes through, all uniformly polarized. Now, to the unaided eye this light appears just like ordinary light. How, then, can we distinguish polarized light? If we take one of the mounted prisms, and look at the clear sky, avoiding, however, the direction of about 90° from the sun, little if any difference in brightness will be observed on rotating the prism while looking through it. But if the other prism is imposed upon it, and one of them is rotated, there will be found two positions 180° apart, when all light is cut off, and the field of view is black; and the light is brightest half way beween these two points. One of these prisms is made to go under the stage, and is the polarizer. The other, the analyzer, generally goes between the objective and tube; or in the Griffith Club microscope it may be fastened to the lower end of the draw tube, in which case it is more convenient to rotate the analyzer than the polarizer, as is usual. In this position, the foregoing experiment may be more exactly made. And polarized light from any source may be detected in a similar way, by examining with one Nicol prism.

Such a prism, then, may be imagined to be a sieve with all the wires parallel, the cross wires being left out; so that only those vibrations continue which are in the direction of the spaces between the wires. If now the other prism is placed over it with the faces parallel, the polarized rays will still pass through unimpeded. This is still true when one of the prisms is rotated 180° around from the first position. But at 90° between, on either side, total darkness results, since then we have to imagine two sets of parallel wires, at right angles to each other, so that all other vibration is stopped.

In themselves, these phenomena are not very interesting. But if different transparent objects, as scales of mica, or other thin sections of transparent minerals, thin sections of plant or animal tissues, starch grains, wool or cotton fibers, drops of chemical salts evaporated on glass slips, old lard and similar substances be interposed between the polarizer and analyzer, and one of the prisms be then revolved, a display and shifting of colors is then observed which in exquisiteness and dazzling beauty surpasses anything ever seen with the naked eye. For most objects, especially the preparations of chemical salts, a $\frac{3}{4}$ inch objective is satisfactory. While for such as vegetable thin sections a $\frac{1}{5}$ objective is desirable. Among the latter the cross section of a *Nuphar* stem makes a fine object. Some of the most satisfactory preparations of salts are salicin, santonin, tartaric acid, cream of tartar, cadmium bromide and sulphate, potassium ferrocyanide and citrate and rock candy. Salicin requirss to be crystallized from a hot solution. Deliquescent salts, as calcium chloride and nitrate, should be warmed on the slide, when the process of crystallization can be well observed. Such remain as liquid drops on the slide for a long time, and can be repeatedly heated. Those salts which effloresce make preparations of only short duration. Some salts, especially of ammonium, evaporate sooner or later. But many of these preparations keep well for months, even without cover glass, if protected from moisture and dust. It should be added that some salts, as the chlorides of potassium, sodium and ammonium, give no play of color. Also the crystals of colored salts, as potassium permanganate, copper sulphate, generally do not change color. Of the natural minerals, thin sections of gneiss, granite, marble, gypsum, hornblende and agate are among the most brilliant polariscope objects. But here it must be remembered that there is a maximum and minimum thickness, varying with different minerals outside of which this play of colors cannot be produced. Thus sulphate of lime may have a minimum thickness of .425 mm., and a maximum of 1.27 mm. Mica must be at most .85 mm. thick; crystalline quartz sections, at most .45 mm. It is difficult to get colors with sections of Iceland spar itself, because the thickness of the sections must not exceed the one-fortieth part of a millimetre.

Thus, while we have in the microscope itself an instrument for revealing a wonderful variety and beauty of form hidden to the naked eye, the polariscope reveals matchless beauty of color, of which no microscopist, no teacher of the youth, in fact no one, can afford to be ignorant. These phenomena are of surpassing interest in themselves. And the chief object in writing this paper is to direct to them the attention of all concerned. It would lead into deep water, and would be far from interesting, to treat here more fully the laws of crystallization, the optical properties of crystals, the intimate relation of the force of crystallization and of light as suggested by the phenomena of the polariscope, unless the reader be first familiar with the facts. Those interested will naturally go to the higher works on this subject. The writer has access only to Deschanell's Natural Philosophy, and to a French work by Guillemin, "Les Phenomenes de la Physique," both very helpful to a good understanding of this subject. But first of all—facts; let every one who can afford it get a polariscope, and set about seeing these things for himself.

Finally, a word about the practical uses of the polariscope. So far it has figured as only an exquisite toy, or by suggestion at most as an aid in unraveling the mysterious nature of light and its relation to chemical force and crystallization. Perhaps in this same category may be placed the first use here to be mentioned, namely, that of determining whether bodies like the planets and the moon shine by reflected light or are self-luminous. For reflected light, being polarized, if examined through a Nicol prism, will darken the field of view at two points 180° apart. Then the play of colors in certain of the plant and animal tissues, show that the cell walls in these tissues are doubly refractive. As Arago has shown, the jeweler may use the polariscope as a test of precious stones, by measuring the polarizing angle on one of the ground faces; for instance that of the diamond is 67° to 70°; of flint glass, 57° to 58°. So, also, in crystallography in general, the polariscope enables us to distinguish crystals with one or two axes and to determine their position. Further, in the investigation of sugar adulteration, or saccharimetry, this instrument is invaluable; for by it the proportion of pure sugar in a given solution can be detected. Lastly, a Nicol, prism so adjusted that the principal section is vertical, will absorb the polarized rays reflected from the surface of water, and thus submerged objects, ahead of a vessel at sea, are made visible by the refracted rays from those objects.

If after reading these lines some few take an interest in the polariscope, the writer will feel amply repaid. We must not expect to become a Nicol, a Huygens, a Malus, a Biot, a Brewster or a Fresnel. But after we have used the polariscope we shall at least delight in thinking after these men their thoughts on the abstruse subjects that cluster around polarization.—*The Microscope.*

ISOLATION OF A CHOLERA TOXINE.

Herman Scholl (*Berlin. Klin. Woch.*, October 13, 1890) communicates an interesting paper giving the results of some experiments with a poisonous body isolated from cultivations of the cholera bacillus. He thinks it curious that in all previous investigations on the nature of the cholera toxine cultivations should have been used which had been grown in the presence of air, whereas, in his opinion, in order to imitate the conditions under which the cholera bacillus grows in the human intestine, the most essential point is that the culture be grown in the absence of air. In this assumption he follows Hueppe and Cartwright Wood, who, he considers, have satisfactorily shown that the cholera bacilli grow in the small intestine in the absence of oxygen, and that their extreme virulence or rapidity of poison production depends chiefly on this anaerobic growth. Other observers, among whom Petri may be cited, think that this point requires more rigorous proof than has yet been afforded. To obtain this anaerobic growth the author used the method introduced by Hueppe of growing the bacilli in raw eggs, by which means he holds that oxygen is completely excluded. The inoculated eggs were kept for eighteen days at a temperature of 96.8° F. When opened the contents were found to give off a very powerful smell of sulphuretted hydrogen, differing in this from cultures grown in air. He describes the white of the egg at this period as being fluid and watery, the yolk firmer in consistence and black in color. In order to test the toxicity of the egg contents 5 cubic centimetres of the fluid part were injected into the peritoneal cavity of a guinea-pig. The animal at first showed signs of paralysis, then convulsive movements, and died at the end of forty minutes. This proved that the fluid egg albumen was very poisonous. The author then proceeds to describe his method of isolating the poison. Shortly, it is as follows: The fluid part of the egg contents, which amounted to 150 cubic centimetres, was dropped into ten times its volume of absolute alcohol. The white precipitate thrown down was collected and digested with 200 cubic centimetres of water at 104° F. The effect of this was to dissolve only a very small quantity of the precipitate, which was then removed by filtration. Eight cubic centimetres of the transparent filtrate were then injected into the peritoneal cavity of a guinea-pig, and caused death in one minute and a half. This fluid entirely lost its poisonous properties on being boiled in the steam sterilizer for half an hour, whilst a short heating to 167° F. had no such effect. On the other hand, when placed at 104° F. *in vacuo*, over chloride of lime, the fluid was found next day to be completely inert. The author then subjected the poison to the usual chemical tests, and came to the conclusion that it was no ptomaine, but a peptone, differing, however, from the toxo-peptone isolated by Petri from aerobically grown cultivations. This peptone could be obtained in a solid form by dropping the watery solution into 8 to 10 times its volume of a mixture of the ether and alcohol, rendered faintly acid by acetic acid. The resulting precipitate was found to be insoluble in pure water, but soluble on the addition of an alkali. After repeating this precipitation and re-solution several times, pure ether was substituted for the mixture of ether and alcohol, and the peptone obtained after evaporation as a white bulky substance. A very small quantity of this dissolved in water was then injected into the peritoneal cavity of a guinea-pig. The animal at once became totally paralyzed. After half an hour convulsive movements of the head and extremities set in, and, at the end of five hours, the guinea-pig died. The author concludes, as the result of his experiments: *First.* That the poisonous peptone, elaborated by the cholera bacilli under conditions of anaerobiosis from the albumen of the egg, is different from the toxo-peptone of Petri, since the latter was not decomposed on boiling, while the former was. *Second.* That this cholera pepto-toxine is much more poisonous than the toxines found by Brieger and Petri in cultures grown under aerobic conditions, since the poison obtainable from a single egg was capable of killing ten guinea-pigs in the space of ten minutes. *Third.* That these experiments are in favor of the contention of Hueppe and Wood that the cholera bacilli, when grown anaerobically, form a greater quantity of, and a more powerful, poison than when grown aerobically.—*British Medical Journal.*

PURE CULTURES.

By a pure culture is generally understood one which contains but one form of life, a single definite micro-organism. This use of the term "pure culture" is justifiable so long as the use which is made of the culture is only morphological. Pure cultures of this type answer all requirements for the classification of micro-organisms, for their morphological study. They might with propriety be termed "morphologically pure cultures." The absence of the limiting word, however, has led to an improper idea of the purity of these cultures, and to a use of them for chemical purposes that is not strictly justifiable. Since the time when Brieger sowed such morphologically pure cultures in various media, and extracted therefrom the ptomaines formed, it has become customary to form similar cultures with pathogenic germs and to extract from them the poisons formed, so far, ptomaines or alkaloids, and toxalbumins, and to attribute the poisons so obtained to the biological activity of the germs. In the main, no doubt, this conclusion is correct. But it is not necessarily correct.

The experiments of Vaillard and Vincent with the tetanus bacillus referred to last week led them to believe that this bacillus formed an enzyme or unorganized ferment. Whether this be true or not, there can be but little doubt but that some micro-organisms do produce such enzymes or soluble ferments. We do not wish to draw any hairsplitting distinctions between a germ and its enzyme, being willing to recognize that the chemical products of the enzyme are the chemical products of the biological activity of the germ. But herein lies the difficulty. The mechanical methods in vogue of separating germs from each other, and securing morphologically pure cultures of individual micro-organisms, afford no guaranty that there has not been carried along with one germ, some of the enzyme of another to contaminate the resulting culture. A culture, then, may be pure, morphologically, but at the same time be contaminated with the enzyme of another germ. It is not a chemically pure culture.

It is true that an enzyme cannot multiply while the organized ferment, the germ, can, so that in succeeding cultures absolute purity may be obtained.—*Jour. of Amer. Med. Ass'n.*

STAINING BACILLUS OF DIPHTHERIA.

The following is Dr. Sims Woodhead's process for staining the bacillus of diphtheria: "It is only necessary to remove a small fragment of the false membrane by means of a piece of absorbent cotton tied firmly to a pair of forceps; from this it is transferred to a scrap of blotting-paper, and thence to a cover-glass, where it is broken down as finely as possible, heated over the flame in the ordinary fashion, and stained with Lœffler's alkaline methylene blue, or by a method adopted by Roux and Yersin who use a blue composed of equal parts of aqueous solution of violet dahlia and methyl green, with water added until a clear, but not too deep, blue is obtained. A drop of this is placed on a slide, the cover-glass on which the fragments are dried is inverted and lowered on it, the superfluous fluid is removed with a piece of blotting-paper, and the organism is examined at once. The organisms occur in small groups, as short, straight or curved rods, with ends sometimes pointed, sometimes curved."—*St. Louis Medical and Surgical Journal.*

DIFFERENTIAL STAINING OF HUMAN BLOOD CORPUSCLES.

Have at hand two clean cover-glasses. Clean and cord the left forefinger, and prick it with an aseptic cambric needle. Breathe upon one cover-glass and touch it to the drop of fresh blood, and immediately breathe upon the other cover-glass and lightly place it upon the first. Just enough moisture should adhere to the cover-glasses so that the blood will diffuse itself over the entire surface of both. Separate the two glasses by a sliding and circular motion. Allow them a few minutes to dry; then pass two or three times through an alcohol flame, and lay them with the coated side up upon a sheet of blotting-paper. With a drop-tube place two or three drops of eosin solution upon each glass, spreading it carefully over the whole surface; let it remain five minutes, then wash the glass by waving it in water. Place the glass again upon the blotting-paper, with the coated side uppermost, and with a hand bulb, such as dentists use to dry the cavity of the tooth, blow all the water from the surface. If the water is not removed at once, it will dissolve and diffuse the coloring matter and render the specimen worthless. Proceed in the same way with aniline blue. Let it remain five minutes, wash and dry in the same manner, and finally mount in balsam. If properly prepared, the specimen will show the red corpuscles colored a beautiful pink, and the white a pale blue or light purple with several dark-blue nuclei in each.—*Dr. Rogers, Microscope, March,* 1891.

BACILLI IN SYPHILIS.

Dr. Von Marschalko has devised a method of staining by which, it is said, bacilli may be found in syphilitic growths of various kinds, such as papules on the skin, the indurated base of a chancre, and condylomata, as well as in the secretions of primary sores. The method employed is by double staining, as follows: The object, after having been hardened in alcohol, is immersed for thirty-six hours in an alkaline solution of methyl blue; it is then rinsed well with water and restained with a concentrated solution of vesuvin in water. By this process the bacilli are stained blue and can easily be distinguished from the tissues, which are brown. The *Lancet* for April 25 contains a more extended notice of this author's study of the bacteriology of syphilis.—*New York Med. Journal.*

READING NOTICE.

THE MISSISSIPPI VALLEY MEDICAL ASSOCIATION.

The next meeting of this select body of medical men meets October 14, 15 and 16, 1891, at St. Louis, Mo. Dr. I. N. Love, Chairman Committee of Arrangements, 301 N. Grand Ave., St. Louis. A very profitable time is expected. Every member should be present and new ones should join. It is proposed that the Medical Press Association have a conference at the same time and place on that occasion. All interested in the society and the medical press should not fail to appear.

LITERATURE.

BY FLOYD DAVIS, M. S. C., PH. D.

POTABLE WATER: Published by Silver, Burdette & Co., Boston. This very interesting and useful little work is very timely and should be in the hands of every family. It contains excellent suggestions of a sanitary character concerning Potable Water, and explains well what constitutes pure and safe water for family consumption. The matter is presented in nine chapters covering "pure water," constituents of water, micro-organisms, purification, filtration, etc.

THE ARENA. The August number of this most excellent and worthy magazine is indeed "brilliant and unique." It presents eight exceedingly interesting articles written by as many leading women-thinkers of the age. The appearance of so many earnest, able female writers in one single issue of the *Arena* is doubtless original among reviews but it adds to the brightness of the whole.

Aside from their presentations, very serious topics of the times, such as "The Farmers' Alliance," "The Tyranny of Nationalism," are most ably discussed by men. The *Arena* is now a leading review in the world of English literature, and we look forward for each number with increasing interest.

The September number of the *Arena* will contain a very timely paper in view of the great agitation now in progress at Chautauqua on the subject of woman's dress. This paper, which is entitled "Fashion's Slaves," is prepared by the editor and is profusely illustrated, containing exact reproductions of prevailing fashions in the sixties, seventies and eighties, together with finely executed photogravures of Greek costumes and popular stage fashions as worn by Modjeska, Mary Anderson, Margaret Mather and Miss Marlowe. This paper will attract general interest.

The frontispiece of the September *Arena* will be a fine portrait of the Rev. George C. Lorimer. The distinguished Baptist divine will discuss in this issue the "Newer Heresies," such as held by Dr. Briggs and his co-laborers.

LIPPINCOTT'S MONTHLY MAGAZINE.

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Carlotta's Intended	Ruth McEnery Stuart.
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Where Love Hath Been	Susanna Massey.
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Real People in Fiction	William S. Walsh.
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Thou or I	Jeanie Gwynne Bettany
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His Majesty, the "Average Reader"	Edgar Fawcett.
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POPULAR SCIENCE MONTHLY FOR SEPTEMBER.

Prof. John Fiske will open the September *Popular Science Monthly* with a paper on The Doctrine of Evolution: its Scope and Infuence which can not fail to give the reader a better understanding of this great method than generally prevails.

An essay by HERBERT SPENCER on THE LIMITS OF STATE-DUTIES will be published in *The Popular Science Monthly* for September. Mr. Spencer maintains that an industrial state should not attempt to mold artificially the minds and characters of its citizens, and gives several striking instances in which such paternalism has wretchedly failed of its purpose.

Continuing his "Warfare of Science" series in the September *Popular Science Monthly*, Dr. ANDREW D. WHITE will relate how hygiene succeeded fetichism as the reliance of the Western World in checking the ravages of epidemics. Other most interesting papers on glass-making and on other attractive topics will appear.

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Vol. I. BATTLE CREEK, MICH., U. S. A., SEPTEMBER, 1891. No. 9.

NEW CONTRIBUTIONS TO SCIENCE.

AN EXPLANATION OF THE PHENOMENA OF IMMUNITY AND CONTAGION, BASED UPON THE ACTION OF PHYSICAL AND BIOLOGICAL LAWS.

[Concluded.]

BY J. W. M'LAUGHLIN, M. D., AUSTIN.

Read before the Texas S. M. A., 1891.

SUMMARY.

THE explanation of the phenomena of contagion which our theory offers is based upon the application of the laws of wave-motion to the motions of complex organic molecules; thus, when waves of sound, of light, or of water meet other similar waves, the amplitudes of the resulting waves are increased;

when, however, the waves are dissimilar, the amplitudes of the resulting waves are diminished. As a means of illustration we will apply these laws to waves of water. Now, a wave of water has certain dimensions, *e. g.*, it has a front, a back, a crest, a trough, and has amplitude. The crest is the top, and the trough is the bottom of the wave; amplitude is the distance from the top of one to the top of the next (nearest) wave.

Now, when two bodies of water, approaching each other from opposite directions, meet, if the waves of each body coincide in the time of their upward and downward movements, the resulting waves will have their amplitudes enlarged, *i. e.*, the distance from crest to crest will be lengthened; if, however, the approaching waves do not coincide in time, should the crest of one set coincide with the trough of the other set, the amplitudes of the resulting waves will be shortened; or the downward force of one set of waves meeting the upward force of the other set, the result may be a complete antagonism of forces and the waves may be destroyed.

Assuming that the movements of complex organic molecules are also governed by these laws, it follows that when molecular waves of one combination meet waves of another combination, the waves of the first coinciding with those of the second, the amplitudes will be increased in the waves of that substance which is the least firmly fixed in its structure. This increased amplitude means an increased distance between such waves; and when the distance is sufficiently great to remove the molecules beyond the limit of their attractions, the combination becomes disrupted, and the molecules liberated. It is well known that these liberated molecules cannot long remain in this free condition; they will be forced, by their mutual attractions, to recombine into combinations of simpler, and, for this reason, more fixed substances. It follows, as a result of these disrupting forces, that this new combination must have periods of molecular vibration that do not coincide with those of the disrupting cause. Hence, the molecules of this new compound will interfere with the movements of the molecules of the other substance, and, when the interference is sufficient, will destroy them, just as interfering water-waves destroy other waves of water. In harmony with these facts we can understand how the molecular movements of a bacterium cell disrupt the molecular combination of albuminoids, and why the ptomaines, which result from the re-arrangement of the liberated molecules, have the power of arresting or destroying through their interference the destructive forces of the cell.

IMMUNITY — HOW SECURED.

Immunity signifies a condition of body which opposes the development of infectious processes, or more accurately stated, it is a condition of the body which opposes the invasion of bacteria. We will not stop to discuss the many theories — beautiful, ingenious, but incompetent — which have been suggested in explanation of how immunity is secured, but will proceed to show that an application of the laws of wave-motion to organic molecules, together with the application of the laws of descent to the evolution of cells, will furnish a complete explanation of all the known phenomena of immunity.

The physical and biological premises upon which this theory of immunity is built, postulate the necessary existence of a natural law of immunity from bacterial influences, through the operation of which all organisms, both animal and vegetable, are to a large extent rendered immune from the action of bacteria-cells; the exceptions to the universal prevalence of this law constitute individual or racial susceptibility to infectious processes. Hence it becomes necessary to explain the causes of this natural law of immunity, and later, to indicate and explain the causes of its exceptions. That man and animal are, as a rule, exempt from bacterial invasions, is evident; were it not for this law, man would be destroyed by the hordes of microbes which surround him, and would attack him from all sides, which enter his body with the air he breathes, with the food he eats, and with the water he drinks. In the face of such a vast army of foes he would be absolutely helpless, if it were not for this natural law of immunity. It will perhaps be answered that the reason man escapes injury from this horde of bacteria is to be found in the fact that they are innocuous. This answer is only partially true, for while they may be innocuous to man, they are frequently virulent to other animals; besides, this answer does not carry with it an explanation of why they are innocuous to man. The answer to this inquiry will necessarily include an explanation of the natural law of immunity. An investigation into the working of this law discloses the fact that differences exist among different races of people, and, to a less extent, individuals of the same race, regarding the kind of immunity which this law secures to them ; *e. g.*, it is established that certain races are largely immune from yellow fever, and other races from syphilis, while individuals of these several races possess different degrees of susceptibility to these influences. Admitting that this racial, and, to a less extent, individual, immunity may in part result from long exposure to the infecting causes, the principal cause, it must be conceded, rests upon structural differences between the races.

In a series of articles, published in the *Lancet* in 1888, upon the pathology of infectious and infective diseases, Dr. Joseph Coates, the eminent pathologist, in discussing the causes of natural immunity, uses the following language in the summing up of his conclusions : "We have seen that, in the case of a large number of diseases of this class, inheritance, whether we take it more broadly in the race, or more particularly in the family, has an undoubted, and frequently a very great, influence on the susceptibility to infection. This varying degree of susceptibility exists in the cases of diseases which are demonstrably due to a micro-organism which is pathogenic in the individuals of one race to a high degree, and is non-pathogenic, or nearly so, in individuals of another race. Recurring to our remarks on the general principles of inheritance, it seems necessary to refer this difference in susceptibility to fine differences in the structure and activity of the tissues. We have seen that the differences in the races depend on variation in the details of their tissue." There are two theories of immunity before the world for a verdict, to which we must devote some attention. The theory of phagocytosis ascribes to certain cell-elements, *e. g.*, the white blood-cells, connective-tissue cells, endothelial cells, and cells of spleen, bone, marrow, and lymph-glands, which are generically called phagocytes, the property of attacking and devouring bacteria. It is said they cannot devour the pathogenic forms until they have been put through a system of training with the attenuated ones, Metschnikoff is the founder and leading advocate of this theory.

other eminent bacteriologists, however, have verified the work done by Metschnikoff, and are equally zealous with himself in asserting the truth of the theory. The second theory ascribes to the normal tissue-fluids of the body a germicidal action. This theory is based upon carefully conducted experiments by Nutal, Büchner, Labarch, and Prudden, with blood serum and other tissue fluids, associated with and also separated from their cellular elements, and, it is claimed, proves that these fluids, and not the cells they contain, are highly germicidal to many, but not to all, bacteria. While one theory seems to oppose the other, in so far as one ascribes the germicidal action to the cell-elements, and the other to tissue fluids and blood serum, although deprived of cells, this opposition in fact does not exist; for it is more than probable that both cells and fluids of the body are germicidal; at the same time the germicidal powers may greatly differ in important respects. While the fluids may be competent to destroy some varieties of bacteria, they may be incompetent to injure the other varieties, or the cells may be competent to resist bacteria that are inimical to the fluids. The following quotations from Dr. Prudden's article on "The Germicidal Action of Blood Serum and Other Body Fluids," may be heard with interest: —

"To account for the disappearance of pathogenic bacteria in the body, either in the course of an acute infectious disease, or as the result of exposures which we may sustain unharmed, several more or less plausible theories have been evolved.

"That one of these which has attracted most attention partly because it has been most ably advocated, and partly because it lends itself most readily to experimental observation, is that called the theory of phagocytosis. This theory is too well known to require detailed exposition here; suffice it to say that it postulates the taking up into their bodies and the destruction there of living micro-organisms by certain lowly organized cells, especially the leucocytes. A large amount of very plausible experimental evidence has been adduced in favor of this theory, and a good deal of this evidence has been unconditionally accepted by medical men. Metschnikoff, the chief expounder of this theory, claims that this destruction of the life of the bacteria by being taken into the bodies of certain cells, phagocytes, is the exclusive means which the organism makes use of in resisting the incursions of pathogenic bacteria. An animal whose leucocytes can successfully battle with and eat up a given species of bacteria, according to this theory, enjoys immunity from its deleterious affects.

"But the doctrine of phagocytosis, at least in the scope which is claimed for it, appears to most unprejudiced observers less and less to commend itself, the more facts and observations on which it is based are critically examined and judiciously interpreted.

"The series of observations on which this theory largely rests, varied and elaborated in many ways, indisputably teach this, that when micro-organisms are introduced into the body, either naturally or artificially, the phagocytes which gather around them may be found after a time to have taken more or less of the germs into their bodies, where they show the morphological evidences of degeneration, which indicate that they are dead. That this phenomenon does occur is well enough established, but that it should be interpreted as necessarily meaning that the micro-organisms are taken in the living condition into the bodies of the cells, and are there deprived of life, appears to be very doubtful indeed."

This quotation is sufficient to indicate that phagocytosis, like the Scotch verdict, is not proven.

Let us now learn what Dr. Prudden has to say, in the same article, regarding the germicidal properties of blood serum and other tissue fluids. We will quote from his summary, and the concluding remarks of the article referred to: —

"It will thus appear, as to the general result of all this recent work, that, first, blood serum possesses, though in different degrees in different animals, and in varying potency with the different bacterial species, a most marked germicidal power; that a similar germicidal power resides in fresh human non-inflammatory transudations. That this power is not directly associated with the formed elements of the blood or the transudates, but is in some way dependent upon their albuminoid constituents. It would further appear that this singular, and, apparently, most significant capacity of the body fluids, is intimately associated with the complex condition which we call life."

"The significance of these new discoveries would seem to be very great and far-reaching, and not only in explaining many obscure phenomena of the acute infectious diseases and in their bearing on immunity, but also in calling back the attention of therapeutical adventurers from germicidal warfare with certain forms of infectious diseases, to what appears to be a natural defense of the organism against bacterial invaders, namely, a healthy condition of the blood. . . .

"But our knowledge of this subject is too fragmentary and too little digested to permit us to do more at present than follow the general indications of its lead. . . .

"The fact that one of the most abundant of the pathogenic bacteria, the staphylococcus pyogenes aureus, appears to be quite invulnerable to this destructive agency, would indicate the necessity of cautious inferences. . . .

"It is a little humiliating, though doubtless salutary, to find ourselves face to face with a series of phenomena which seem to lie at the very basis of the knowledge of acute infectious diseases, and yet be able to say only that they are the result of the vital forces."

These quotations from Dr. Prudden's paper furnish us the salient features of the two theories of immunity, some of the objections which are urged against them, and evidence of their incompetency to explain all, or even a large part, of the phenomena of immunity; they also give us an idea of the character and extent of known phenomena of natural immunity, which must be rationally explained by any theory before its truth can be accepted.

The chief difficulties, as I conceive them, which stand in the way of a correct knowledge of the laws of natural immunity, are found in the obscure vitalistic conceptions entertained regarding the structure and activities of tissue, and the laws of inheritance in their application to the evolution of cell-development. We will endeavor to show that structure is an arrangement of molecules in cells, and the difference of structure consists in difference of molecular combinations with their associated movements in definite periods of time; and that these varying forms of molecular aggregation, whether found in cells, in protoplasm, or in albuminoids, have resulted from the operation of the laws of natural selection, heredity, and adaptation. These views will no doubt appear to many persons quite startling, as do all declarations which seriously disturb the usual order of prevailing opinions of men. It can hardly be claimed, however, that they are untenable; on the contrary, they are based on accepted physical laws, and explain many phenomena which cannot otherwise be explained, whether these are observed from the standpoint of the physiologist, the biologist, the physicist, or the chemist. The warrant for making the statement is found in the writings of Michael Forster, Professor Huxley, Professor J. Clerk Maxwell, and Julius Thomson; it is needless to say that the opinions of such men, in matters relating to their special departments of science, are entitled to the greatest respect. Professor Michael Forster, M. D., says: "We have, in speaking of protoplasm, used the words 'construction,' 'composition,' 'decomposition,' and the like, as if protoplasm were a chemical substance. And it is a chemical substance in the sense that it arises out of the union or coincidence of certain factors which can be resolved into what the chemists call 'elements,' and can be at any time, by applying appropriate means, broken up into the same factors, and indeed into chemical elements.

"This is not the place to enter into a discussion of the nature of the so-called chemical substances, or, what is the same thing, a discussion concerning the nature of the matter; but we may venture to assert that the more these molecular problems of physiology, with which we are now dealing, are studied, the stronger becomes the conviction that the consideration of what we call 'structure' and 'composition' must, in harmony with the modern teachings of physics, be approached under the dominant conception of modes of motion.

"The physicists have been led to consider the qualities of things as expressions of internal movements; even more imperative does it seem to us that the biologists should regard the qualities (including structure and composition) of protoplasm as in like manner the expression of internal movements.

"He may speak of protoplasm as a complex substance, but he must strive to realize that what he means by that is a complex whirl, an intricate dance, of which what he calls chemical composition, histological structure, and gross configuration, are, so to speak, the figures: to him the renewal of the protoplasm is but a continuance of the dance, its functions and actions the transference of figures. . . . And the conception which we are urging now is one which carries an analogous idea into the study of all the molecular phenomena of the body.

"We must not pursue the subject any further here, but we felt it necessary to introduce the caution concerning the word 'substance,' and we may repeat the assertion that it seems to us necessary, for a satisfactory study of the problems on which we have been dwelling for the last few pages, to keep clearly before the conception that the phenomena in question are the result, not of properties of kinds of matter, in the vulgar sense of these words, but of kinds of motion."*

Professor Huxley says: "The broad distinctions which, as a matter of fact, exist between every known form of living substance and every other component of the material world, justify the separation of the biological sciences from all others. But it must not be supposed that the difference between the living and not living matter is such as to justify the assumption that the forces at work in one are different from those to be met with in the other. Considered apart from the phenomena of consciousness, the phenomena of life are all dependent upon the working of the same physical and chemical forces as those which are active in the rest of the world.

"It may be convenient to use the terms 'vitality' and 'vital force' to denote the causes of certain great groups of natural operations, as we employ the names 'electricity' and 'electrical force' to denote others; but it ceases to be proper to do so if such a name implies the absurd assumption that 'electricity' and 'vitality' are entities playing the part of efficient causes of electrical or vital phenomena.

"A mass of living protoplasm is simply a molecular machine of great complexity, the total results of the working of which, or its vital phenomena, depend on the one hand upon its construction, and on the other, upon the energy supplied to it; and to speak of 'vitality' as anything but the name of a series of operations is as if one should talk of the horology of a clock."†

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* Encyclopedia Britannica, 9th ed., article, Physiology.

† Ibid., article, Biology.

Professor J. Clerk Maxwell says: "Thus molecular science sets us face to face with physiological theories. It forbids the physiologist from imagining that structural details of infinitely small dimensions can furnish an explanation of the infinite variety which exists in the properties and functions of the most minute organisms.

"A microscopic germ is, we know, capable of development into a highly organized animal. Another germ, equally microscopic, becomes, when developed, an animal of a totally different kind. Do all the differences, infinite in number, which distinguish the one animal from the other, arise from some difference in the structure of the germs? Even if we admit this as possible, we shall be called upon by the advocates of pangenesis to admit still greater marvels. For the microscopic germ, according to this theory, is no mere individual, but a representative body, containing members collected from every rank of the long-drawn ramification of the ancestral tree, the number of these members being amply sufficient to furnish not only characteristics of every organ of the body and every habit of the animal from birth to death, but also to furnish a stock of latent gemmules to be passed on in an inactive state from germ to germ, till at last the ancestral peculiarity which it represents is revived in some remote descendant."*

Julius Thompson, in his introduction to "Thermo-chemical Investigations," says: "Theoretical chemistry is based upon the molecular theory, according to which all matter is made up of molecules, and these molecules of atoms. The physical state of bodies depends upon the arrangement and motions of the molecules, the other physical and chemical properties depend upon the kind and number of atoms in the molecule, upon their arrangement and relative motions."†

In a former part of this article we endeavored to explain that certain cells would be virulent to other cells when the first were able to disrupt the molecular combinations of the second, and that this power of disruption was exercised by the more stable molecular combinations, whose periods of molecular vibrations coincided with the less stable in periods of recurrence. Under these conditions the cells of virulent bacteria, with their contained molecules vibrating in definite periods of time, would shake apart the molecules of other cells or molecular combinations, *e. g.*, the albuminoid molecules of the cell-elements or fluids of the blood or tissues of man, provided these vibrated in periods of time coinciding with those of the bacteria cells; for the reason that the first are more fixed in their molecular combinations than the second, and consequently are better able to withstand the increased kinetic energy manifested by an increase of wave amplitude, which molecular waves, rapidly superposed on other molecular waves of the same periods of recurrence, would necessarily induce.

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* Ibid., article, Atom.

† W. R. Nichols: Popular Science Monthly, October, 1883.

Bacteria cells whose wave-lengths do not coincide in periods of recurrence with those of any cells, blood serum, or tissue fluids of man would for this reason be innocuous to man. At the same time they might find, in fluids or tissues of other animals, molecular combinations which these bacteria could disrupt, and for this reason they would be virulent to such animals.

I presume that no one will deny that the normal tissue fluids of man's body, vary in many respects, and that these variations correspond to the ultimate use of such fluids in supplying the different cells of the body with the means of repair and regeneration. Admitting this proposition, it follows that different cells and different fluids of man's body, notwithstanding their macroscopic or even microscopic similarity of appearances, possess molecular combinations differing among themselves, and peculiar to each class or variety, and consequently cannot be affected alike, or at all, by the same bacteria; some bacteria would find vulnerable structures in the blood and other fluids of the body, others in the fixed cells, and others perhaps in the contents of the alimentary canals. Some would be virulent to man and innocuous to animals, others would be virulent to some animals and innocuous to others, and would thus present many differences of action — which in fact are found to exist in nature.

Cell structure is thus resolved into molecular combinations, while cell immunity is the result of molecular vibrations. Hence it follows that the law of natural immunity depends not alone upon inherited qualities acquired by man as a complex cellular organism, but also upon qualities which each individual cell or molecular combination has acquired for itself through the operation of the laws of inheritance and adaptation.

We have already endeavored to outline the results that would be obtained by the application of the laws of natural selection, heredity, and adaptation to the evolution of cell life.

In an infinite number of created cells there would exist infinite differences in their molecular combinations, which would determine species and varieties, and would also determine the lines of development which the different species and varieties would pursue, as well as the extent of development which the species and varieties could attain. Thus, in consequence of this molecular structure, some cells would find their fixed point of development in unicellular organisms, while others would enter into and assist in the formation of complex multicellular organisms. All cells from the beginning, in consequence of the differences in their molecular combinations causing equal differences in their molecular vibrations, would wage incessant war upon each other because of the actions, interactions, and reactions of their molecular vibrations, until there would eventually result an adjustment of their forces, through the operation of the laws of natural selection, heredity, and adaptation, resulting, to a great extent, in their individual and special immunity. By natural selection we mean that law of nature whereby she selects from a large number of organisms those varieties and species which are in best harmony with their environment. By heredity we understand that natural law which transmits through the race those qualities, possessed by varieties or species, which determine their selection by nature. By adaptation we understand that law which enables organisms, during their generation, to adjust themselves to their surroundings; qualities thus acquired may be, to a limited extent in long periods of time, transmitted through inheritance. Environment constitutes those natural causes, *e. g.*, climate, food-supply, temperature, moisture, etc., which determine the species or varieties which nature will select for the purpose of propagating the kind.

No correct opinion of cell life or the life of cellular organisms can be had. There can be no correct conception of the causes of cell immunity, whether it be a bacterium cell or one found in man's body, or for that matter found in the cells composing his entire body, that is not based upon the evolution of cell life, through the laws of descent from the simple to the complex, and from the undifferentiated to the differentiated cell structure. It is in this manner and in conformity with these laws, that man has acquired his natural immunity from bacterial invasions. The molecular vibrations natural to the various cells and fluids of his body render him immune to a great extent from what might be otherwise fatal influences. Now, these molecular cell combinations and their equivalent molecular vibrations are qualities of inheritance, and represent certain adjustments of molecular force gradually acquired by the ancient ancestors of these cells through wars and battles of cells, the like of which has never occurred in the history of man.

Having thus explained the causes which produced the laws of natural immunity, it would be proper to inquire into the reasons why this law is not absolute in its operations; why man is not immune from all infective and infectious diseases. To enter into this discussion and explain how the laws of natural selection, heredity, and adaptation are equally as competent to explain these exceptions to the law as they are to explain the law itself, would make this already lengthy paper too long to be read on this occasion. I have concluded to pass this portion of our subject, and devote the remainder of this paper to an explanation of the principles involved in artificially acquired immunity. It is well known that immunity from many acute infectious diseases can be secured by artificial means, *e. g.*, one attack often renders the individual immune from future attacks of the same malady. Another artificial means of securing immunity is to be found in what is termed "protective inoculations;" this method consists in the inoculation of an "attenuated" or weakened form of the virulent microbe which is the etiological factor in producing the disease. Thus anthrax, chicken cholera, smallpox, swine plague, and other forms of infectious disease are non-infectious to individuals who have been previously inoculated with the attenuated microbes of that disease from which they seek immunity. "Attenuation" of bacteria is produced differently with different varieties of pathogenic bacteria, and when once accomplished is more or less fixed as a condition of such bacteria. To all appearances they are the same, but are no longer able to decompose molecular substances, provided the attenuation is perfect; there are, however, degrees of this condition, so that the decomposing power of the bacterium will depend upon the extent of its attenuation, *i. e.*, at what point or stage the process of attenuation is arrested; thus the power of the cell to do its specific work is proportioned to the extent of its attenuation. While the attenuated bacterium is usually fixed in this condition, at least to a very considerable extent, and will transmit this quality to its offspring through many generations, it can, by a reversal of the methods of attenuation, be brought back to its original condition of virulency. You will, perhaps, be reminded of the similarity of behavior in this respect between the bacteria and the yeast cells. Oscar Brefeld, you will remember, succeeded, by a peculiar artifice, in modifying these cells in such a way that they would grow and multiply in a solution of malt without producing alcohol.

The third and last means by which immunity against an infectious disease can be secured, is by previously injecting its characteristic ptomaines into the individual, beginning with small amounts and gradually increasing the dose as the individual becomes accustomed to the poison. This means of immunity, by the injection of specific ptomaines, is of recent discovery, and bids fair to become of great practical advantage. It already explains what had been previously very obscure, how the pregnant mother gives immunity, for example, in syphilis, to the child in utero.

It is generally admitted that solid particles, like bacteria cells, cannot pass from the mother through the placenta to her child in a normal state of the placental tissues; hence, the fact of the child's immunity secured through the mother was not understood. That soluble substances like ptomaines can pass in this way by osmosis is not questioned, and in doing so explains how the child receives from the mother immunity from syphilis and other infectious diseases.

These different means of securing immunity from certain infectious diseases, *e. g.*, immunity secured by a previous attack, immunity secured by protective inoculations with the attenuated bacterium, or with the specific ptomaine, appear to be of a very dissimilar character, and cannot be harmonized by any of the theories at present offered in explanation of these processes. It will be observed, however, that when the principles involved in our theory are applied to the elucidation of this problem, a striking similarity of action between these methods is seen to exist, and order is established out of chaos.

I will first invite your attention to the methods of securing immunity by inoculating attenuated bacteria and by inoculating the specific ptomaines, and show that practically the two methods are the same. We have previously explained how the pathogenic bacterium cell, through its molecular vibrations, has the power of disrupting the albuminoid molecules which it finds in the blood or tissue fluids of a man's body, provided that the molecules of this substance vibrate in the same periods of time, crest to crest and trough to trough, in which recur the molecular vibrations of the bacterium cell. This is an important principle, which I hope you will fix in your minds. When two or more molecular combinations — for illustration, two cells whose molecules vibrate in the same period of recurrence — meet in the blood, or any other nutritive solution where the molecular activities have full play, that cell which is best fixed in its molecular combinations will shake apart the molecules of the other cell, drive them beyond their attractions, and thus disrupt the cell When this conflict is between the molecules of bacteria cells and combinations of albuminoid substances, and the battle-ground is the tissue fluids of man's body, the albuminoid molecules will be driven beyond their attractions and the combinations disrupted, for the reason, first, that they vibrated in unison with those of the bacterium cell, and secondly, that they are less fixed in their combination than those of the bacterium cell. Now, when this pathogenic bacterium cell is attenuated, weakened in its power of disrupting the albuminoid molecules, it will produce only small quantities of ptomaine; the amount of ptomaine produced will depend upon the amount of attenuation the cell has received. So that, using these attenuated bacteria as the matter of inoculation amounts to the same thing as using small quantities of ptomaine as the matter for such inoculations; the results obtained and principles involved are the same in either case.

"How does one attack of an acute infectious disease give man immunity from other attacks of the same malady?" is the question that now offers itself for our solution.

A bacterium cell disrupts molecular combinations of the albuminoids when the molecules of each vibrate in the same periods of recurrence; the albuminoid molecules which are thus disrupted or shaken apart, and liberated from their former combinations, will again immediately recombine, because of their attractive affinites, to form other combinations which are called ptomaines. Explanation has been made why these ptomaines must of necessity have molecular vibrations which recur in periods of time that interfere with those of the bacterium cell, and when the ptomaine accumulates in sufficient amount, will, through the action of the law of interference, which applies to all wave-motion, so antagonize the bacterium cell that its action will be destroyed, and it will no longer be able to disrupt the albuminoid combination. It is in this way, you will remember, that the yeast cells are affected by alcohol, their ptomaine, and it is this law of interference which explains why waves of light, or waves of sound, if they recur in different periods of time, may in the one case produce darkness, and in the other produce silence. You will observe that the reason the molecular vibrations of the ptomaine thus interfere with those of the bacterium cell, is due to differences which exist in the vibratory recurrence of the two substances, and that molecular vibrations, like the vibrations of light and sound, are subject to that beautiful and far-reaching law of interference.

Now, as the molecular vibrations of the bacterium cell coincide in all respects with those of the albuminoid combinations which it is capable of disrupting, it follows that the respective ptomaines will affect or interfere with the two substances alike, *i. e.*, the molecular vibrations of two substances being the same, any third substance whose molecular vibrations would interfere with those of one substance, would also interfere with those of the other.

Hence the ptomaine which interferes with the bacteria cells will, for the same reason, interfere with certain albuminoid molecules. You will understand that this interference, exerted by the ptomaine over the albuminoids, will change the molecular vibrations of this substance, that is, will change its molecular combinations, and as long as this interference, or this changed molecular combination, continues, such molecules could no longer be influenced by the bacterium cell, and the individual would be immune from that acute infection to which such bacteria stand in the relation of etiological factors.

Ptomaines are chemical substances, and like other chemical substances, do not find in man's body a permanent abiding-place, but are disposed of or eliminated from the body in a reasonably short time. How, then, are we to explain the more or less permanent immunity which observation and experience teach us is secured by the various artificial means which have been referred to?

The phenomena of interference, manifested in waves of light or waves of sound, continue only during the time that the interfering cause is in operation. You will observe that this rule does not apply to the interference between the ptomaines and the albuminoids. How, then, are we to explain the fact that the phenomena of interference, manifested as change of molecular movements in the albuminoids of the blood, continue to persist more or less permanently after the cause of interference, the ptomaine, has been removed or is no longer a cause of molecular interference? To fully understand this problem, it is necessary to consider the nature of the two substances involved, the ptomaines and the albuminoids. This ptomaine, a product of the disintegration of the albuminoid, is a less complex and more fixed substance than the albuminoid from which it is derived. The ptomaine which will be produced in any given case is determined by the molecular structure of the active causes, the bacteria cells, and the molecular structure of the substance acted upon, the albuminoids; as there are many varieties of the pathogenic bacteria and many differences in the molecular combinations of the albuminoids, there must result many different kinds of ptomaines.

The albuminoids are of course derived from the food we eat, animal or vegetable. The molecular combinations which these substances had before entering our bodies, became greatly changed by heat in the process of cooking them, and further changed by the process of digestion to which they are subjected.

As we find them in the blood or tissue fluids of man, they are plastic molecular compounds, well suited to furnish to the many different kinds of cells of which man's body is composed, matter for their repair or regeneration. It follows that substances possessing such mobile molecular combinations of various kinds would be easily influenced by interfering bodies, and that the new molecular arrangements involved in this process of interference would be more or less permanent, and capable of being transmitted by the act of generation. That this is not an improbable assumption, but, on the contrary, a correct principle, is evidenced by the fact that changes of like nature in the molecular arrangements of cell structure, a much more fixed substance than the albuminoids, do occur from artificial causes, and that such new molecular arrangements become permanent, and are transmitted through the act of generation. I refer to those changes produced in the pathogenic bacterium by the process of attenuation.

Immunity will then be more or less permanent, depending upon the degree of permanency in the molecular combinations of the albuminoids which the ptomaine has imposed upon them. As a matter of fact, infectious diseases differ very greatly, regarding the duration of immunity, if any, which one attack secures to the individual against other attacks. The phenomena, you will observe, in this instance, as well as in all others, are in harmony with, and capable of being rationally explained by, our theory. So far as I know, there is no attempt to harmonize an explanation of these phenomena with the theory of "enzymes," or, for that matter, with any other theory. The atomic theory is accepted, and, in fact, is the foundation upon which is built the beautiful and stately structure, Chemical Science, although no man has ever seen an atom, and for that matter, will never see one; yet it is accepted because it is capable of explaining chemical laws and the phenomena of chemical changes. It can also be said of the undulatory or wave theory of light, the waves are invisible and likely to remain so, but the theory is accepted because of its competency to explain the phenomena and laws of light. And, if you will excuse the apparent egoism involved in making these comparisons, it is because the molecular cell theory is competent to explain the phenomena and laws of infection and infectious diseases, that I am convinced of its truth.

It will, however, do more than this. I am convinced that a right application of the laws involved in this theory is competent to explain many other dark problems of medicine; for example, that obscure subject involved in the power and potency of drugs and their therapeutical uses; and I predict that it will be along these lines of investigation that knowledge is to be obtained and progress made.

IMMUNITY AGAINST THE DIPLOCOCCUS PNEUMONIÆ, PRODUCED BY THE GLYCERITE OF HEPATIZED LUNG.

BY VASSALE AND MONTANARI.

Translated by Hanau W. Loeb, A. M., M. D., St. Louis, Mo., from the *Wiener Klinische Wochenschrift*, 1891, No. 23.*

It has long been known that an immunity against the pneumococcus could be produced by inoculation in rabbits. Foa and Bordoni-Uffreduzzi were able to render this animal immune against virulent cultures by means of injections of old more or less inefficient cultures made at intervals of from five to seven days. Foa states that this is the result of the previous poisoning, that is, by the entrance of the discharged products of the diplococcus. He prepared from the muscles and intestines of a dead rabbit infected with pneumonia, and by precipitating with ammonium sulphate, a substance which, injected into the veins of healthy animals, produced but slight injury, and conferred immunity against virulent cultures (injections in doses from two to four days apart).

Vassale and Montanari endeavored, in keeping with this fact, to discover a similar efficient substance from the hepatized lung of human pneumonia. They took from a patient in the stage of beginning hepatization, a piece of the lobe of the lung (section a short time after death) which was kept at a low temperature in a sterilized, well-closed vessel. About 45 gms. (oz. 1¼) of the lungs were cut fine and cooked in the steam sterilizer and afterward pounded. To this was added 30 parts of distilled water, and the same quantity of glycerine, and the entire solution stirred and filtered. Two rabbits were injected with this glycerine extract in two succeeding days (a total of 9 c. c. in three injections). On the same day the animals were injected with virulent emulsion of hepatized lung. In addition, 1 c. c. of the virulent emulsion was injected into two healthy ones (all four animals of the same age, coming from the same mother, almost the same size and weight). Two days later the latter died from pneumonic infection, and the former, which had been treated with the glycerine extract, were entirely well. Finally they treated an animal with a glycerine extract of a healthy lung, and then injected the virulent emulsion. This one also died of pneumonic infection two days after. From their researches they conclude that a glycerine extract of a hepatized human lung can render rabbits immune against the infection of the diplococcus pneumoniæ.

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* Continuance of Dr. Loeb's translation from July number.

THE SPECIALIZATION OF CELLS.

NINTH INTERNATIONAL MEDICAL CONGRESS, BERLIN.

Translated by Hanau W. Loeb, A. M., M. D., St. Louis, Mo., from the *Wiener Klinische Wochenschrift,* Vol. IV., Nos., 9, 10.

The writer remarked that the majority of histologies were misleading in the differentiation of cells by their adaptations or individual developments which are renewed in succession by external circumstances of seat and vicinity. Some have taken upon themselves to remodel the full-grown, well-differentiated cells; others reject all this, but concede an indifference in the younger cells, especially the known types, the leucocytes, for example. Bard opposes this opinion of the absolute specificity of the cells by which they would be given, exclusively, their specific qualities through heredity. The different cell types form as many families, genera, and species as the animal kingdom; perhaps in the succession of ancestors, they may have had a common origin, but they became isolated, and then they were unable to change one into another.

PARASITIC FUNGI AFFECTING THE HIGHER ANIMALS.

BY GEORGE NORMAN, M. R. C. S., F. R. M. S., ETC.

Having on previous occasions brought under the notice of your readers some of the parasitic fungi affecting our plants and vegetables, our corn-fields and vines, and also some of those attacking insects and fish, I now propose to consider those affecting the higher animals.

In doing this, I must entirely exclude the microbes or bacteria as being essentially a separate and distinct series of organisms, quite alien in their action upon the body, to the fungi I wish to deal with in this paper.

And I will only just touch upon the fact that there are some species of the common moulds which may become saprophytic on animals. If they find a suitable nidus on some effete or cast-off material,— such as excessive or diseased secretions of the skin or mucous membranes,—they rapidly produce mycelium, and even go on to the production of vegetative spores or conidia. The rapid growth of the mycelium may cause irritation or even inflammation, but it never penetrates into the tissues, to the loss of its saprophytic character.

Aspergillus furnishes several species possessing this faculty, one species finding a habitat in the ears of animals and man; another in the air-passages of birds. The *Mucors* proper also furnish other examples. One peculiar feature about these moulds is that they exercise a sort of elective affinity as to their host, some species, for instance, flourishing on the dog, but not on the rabbit, and *vice versa.*

The fungi we are especially concerned with are, however, true parasites, for they live and thrive upon the tissues of their hosts. Their number is not large, but they have a great and special interest for us, inasmuch as they are not confined to animals, but affect man himself, and numerous cases are on record where they have been transmitted from animals to man. The destructive power of these fungi is, however, slight when compared with that possessed by the parasitic fungi we have previously considered, which are in most instances fatal to the host.

The disorganization of tissue produced, although sufficiently disagreeable in its effects, is never fatal to the larger animals, and very rarely to the smaller ones.

There are only three forms with which we have to deal; viz., *achorion*, *trichophyton*, and *microsporon;* and these are now recognized as the causes of three skin diseases, known respectively as *favus*, or honeycomb ringworm, *tinea*, or ordinary ringworm, and *pityriasis versicolor*, a rarer disease than the others, and which has no suitable common name.

Let us consider them, first, from a historical point of view. During the early part of this century, scientific men had not the slightest suspicion of the great part played by fungi in the animal economy. The first impulse to the investigation of the contagious diseases of animals from a mycological point of view, was given in 1835, when Bassi and Balsamo discovered that muscardine, the disease so fatal to silkworms, was caused by a fungus which they named *Botrytis Bassiani*, and which I described in my last paper.* In 1837 Remak described certain peculiar appearances in the skin of animals affected by favus, which he did not think could be accounted for on the supposition that they were merely the result of the drying up of pustules and their products. But it was reserved for Schönlein in 1839 to demonstrate that these peculiar appearances were due to a fungus, which fungus was named by Remak (to his credit, be it said), *Achorion Schönleinei*, in honor of its real discoverer. The roll of scientific nomenclature has not always been built upon such an honorable basis as that. In 1844 the discovery of *trichophyton* as the fungus of ringworm was made simultaneously by Gruby in France and a Swede named Malmsten. Lastly, in 1846, Eichstedt described *microsporon*, the fungus of *pityriasis versicolor.* Since those days the study of mycology has been steadily followed, and in some cases knowledge has increased by leaps and bounds.

But with regard to these fungi; their true position in the mycological system still remains to be defined, owing to the fact that their reproduction has as yet only been observed in the asexual or conidial form, and never in the perfect or sexual form. As I said in my paper on Dimorphism,* the systematic study of the life-history of fungi, is constantly bringing to light the fact that whole families and genera of what were once considered independent fungi must now be looked upon as only stages in the growth of some more perfect forms. It is not at all unlikely that this may be the case with the fungi we have now under notice; but until this point can be cleared up we must consider them as independent species.

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* See *Journal of Microscopy*, 1890, p. 73.

It may be asked whether, in these days of skilled bacteriologists, artificial cultivation of these fungi cannot be made and observed, so that their life-history may be traced out. Cultivations of these fungi have been made, and that for a longer period and to a greater extent than in the case of almost any other kinds, and numerous theories have been advanced in consequence. One theory was to the effect that all these fungi were derived from the same source, viz., a common mould, such as pencillium or an oidium (O. lactis), and that they only differed from one another according to the pabulum they lived on. Another theory was that each of these fungi was simply an alternative form of some other well-known species, such as ustilago, pleospora, etc.

All that modern skill has done in this direction, as yet, has been to show that these theories were based on experiments, the results of which were vitiated by the want of attention to those small details of manipulation which are such an important feature of modern mycological research.

Dr. Thin, who has devoted much attention to the cultivation of these particular fungi, tells us that if we wish to undertake work of this kind, we must first of all satisfy ourselves that we can render and keep pure (*i. e.*, free from the innumerable fungus spores that crowd our atmosphere) the meat gelatine, or whatever medium we intend to use for our experiments. This in itself is a matter that requires some practice, and until the requisite skill is obtained, any further experiments will be worse than useless.

But even skilled observers, after having cultivated pure growths of these fungi on many various media, have been unable to obtain any further results than the production of mycelium tolerably freely; the formation of septa within the mycelium, and, finally, a feeble attempt at the formation of vegetative or asexual spores or conidia. Perhaps, in course of time, some medium may be found in which these fungi may be cultivated more successfully.

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* See *Journal of Microscopy*, 1887, p 129.

The general appearances of the mycelium and conidia in all three forms, whether from artificial cultivations or not, are very similar. At the same time, there is a certain amount of morphological character peculiar to each, dependent, for the most part, on the appearances of the conidia.

In achorion the conidia are numerous, and exhibit great variety as to size and shape, and the mycelium has a peculiar jointed appearance. In trichophyton the conidia are generally numerous, but comparitavely small in size and uniform in shape; the mycelium is small and smooth in appearance. In microsporon the conidia are large in size and uniform in shape, and grouped together in clusters. It is only fair, however, to say that these details need a practiced eye to observe them, and that even then too much importance must not be attached to them.

The fact is, the different effects produced by these fungi on the tissues form the principal means of distinguishing between them, and these we shall have to consider in detail. These three fungi, as far as we know, have no other habitat than the skin of some of the mammalia, and here, even, it is only a certain portion of the skin that is fancied by them. It is the hard or horny layer that is chosen, not the softer mucous layer (the *rete mucosum*), also the hair, especially the space between the inner root-sheath and the cuticle of the hair, also the nails, claws, and hoofs.

Nevertheless, the parasite must grow and thrive, and to enable it to do so it has the power of splitting up the materials on which it grows, absorbing part as food and leaving the rest as foreign matter. This foreign matter, however, acts as an irritant to the tissues of the epidermis, setting up inflammation and giving rise to greater or less disturbances according to the anatomical structure and vulnerability of the parts affected.

Comparing the destructive effect of these three fungi on the skin, we have to give the first place to achorion as the most destructive; trichophyton comes second and microsporon last.

Achorion. — This fungus, producing the disease called favus, is known to occur on mice, rabbits, dogs, cats, and fowls, besides being common in man. It is characterized by the formation of sulphur-yellow masses of the size of lentils, crowded together in a cluster between the layers of the epidermis. These little masses are disc-shaped, depressed in the center, perforated each by a single hair, and are made up principally of fungus elements. This can be shown by making a section of one of these little bodies and placing it under the microscope.

The superficial portion consists of epidermis cells. Beneath this is a finely granular, viscid material, extending into the interior of the mass. Next we find densely packed mycelium, spreading and branching into the interior of the mass, and giving off conidia in increasing numbers as the section is passed through, until at the deepest portion the conidia preponderate. A small portion of this, placed with a drop of water under a higher power (700 diameters), shows the granular viscid mass to be the product of the disintegration of the epidermic cells and of the secretions of the glands. This viscid mass holds together the fungus elements: the mycelium and conidia which have already been described.

If we place one of the hairs which penetrate these little masses under the microscope, with a drop of liquor potassæ to clear it a little, we shall find both in the root-sheath and in the fibrous layer of the hair an abundant network of mycelial threads and conidia.

In considering the development of this fungus, we find that the vegetative spores, or conidia, are fortunately somewhat particular as to the place in which and the conditions under which they will germinate. They seem to require plenty of room and continued quietude for this purpose; and such place and conditions may be found in the funnel-shaped space of the hair-follicle. On other parts of the skin the spores are apt to be rubbed off or disturbed, and hence are not so likely to germinate; but having once got an entrance into the hair-follicle, the needful quietude is obtained and germination commences. The mycelium grows freely in this space, being protected by the epidermic base of the follicle, and in about three weeks from inoculation the yellow mass of fungus surrounding the shaft of the hair shines through the epidermis. The epidermis surrounding and intimately connected with the hair cannot be raised up, but farther away from the hair the epidermis is easily elevated by the growth of the fungus; hence the central depression of the surface of the fungus masses. On the under side the softer epidermic cells are easily compressed laterally and downward by the growth of the fungus, and in this way a pit is formed by pressure, which, however, disappears entirely in recent cases on the removal of the fungus mass. In chronic cases, however, the continued pressure causes atrophy, with baldness and cicatricial degeneration of the skin to a parchment-like condition. Occasionally, too, inflammation secondary to the irritation set up in the tissues by the fungus, may occur, and there may result ulceration and suppuration. Some of the smaller animals are said to suffer much more severely in this way than the larger ones. Thus, in mice, destruction of cartilage and bone and even death is recorded as the result of this disease. In the usual way, however, the fungus mass, after growing slowly for a long time, loses its deep yellow color, becomes of a dirty white color, and owing to the giving way of the epidermis and the protrusion and growth of the fungus masses, of a heaped-up and irregular form.

Ultimately it becomes separated from the epidermis — spontaneously or by mechanical means — and drops off. In the meantime, however, other fresh spots of fungus have probably made their appearance in the neighborhood of the affected part, and so the disease continues its chronic course, often lasting for years.

On parts of the body not covered with hair, the appearance produced by the disease is a little different. The spore, having found a nidus in one of the ordinary follicles of the skin, germinates in the usual way, the mycelium gradually spreads into the adjoining cells of the epidermis, giving rise to a red patch of irritation, which enlarges with the growth of the mycelium. The center of the patch gradually becomes paler as the marginal zone of irritation increases in size, giving rise to an annular or irregular line of redness on the skin, from which circumstance this class of diseases gets the common name of ringworm. Ultimately, however, the typical yellow mass of fungus makes its appearance in the center of the patch, and the red line of irritation dies away as the strength of the fungus is drawn away to its central development.

TRICHOPHYTON.— This fungus, producing the disease known as ordinary ringworm, is very common among the domestic animals, and many cases are on record in which the disease has been communicated from them to man. Thus, young horses bought in the South of France for the French cavalry, are frequently affected with this disease, and a case is mentioned where fifteen soldiers became simultaneously affected with ringworm from sleeping on horse-blankets which had been used for covering horses suffering from the disease. Again, a dog took the disease from lying on a rug which had covered a horse affected with ringworm, and he in turn gave it to his master. Dr. Thin mentions a case where two sisters took the disease from nursing a dog affected with it.

The appearances produced on the skin by this fungus vary very much according to whether it appears on a part of the body covered by hairs or not. On the hairy part of the body the first appearance is that of white scales, producing a scurfy condition of the skin, and accompanied by a breaking away of the hair over a small space. The hair around this spot is lusterless and bent down, as one observer has said, like stalks of corn beaten down by wind and rain. If some of the scaly *débris* be removed from the skin, we may find underneath small vesicles on a red base, and in other parts yellow-brow crusts corresponding to vesicles which have dried up. All these latter appearances are probably simply the result of irritation set up in the tissues by some morbid material brought into existence by the splitting-up of the tissue by the fungus growth.

On the non-hairy parts of the skin the first appearance is usually a small red spot, which soon shows scales. This spot extends as a ring, and on the margin of the ring the scales are very visible, while as the ring spreads, the center becomes pale and free from scales, and some small number of insignificant vesicles make their appearance. These rings may extend to the size of a half-crown or larger, and sometimes two or more rings coalesce, producing a gyrate form.

The spores of trichophyton germinate much more readily than those of achorion; but they have a somewhat different habitat, growing only on the external horny layer of the epidermis and in the substance of the hair-shaft, and between it and the internal root-sheaths of the hair. A spore having reached the skin usually by actual contact with another diseased animal or with some infected article, begins at once to germinate and send forth mycelium, which penetrates the external horny cells of the epidermis. As soon as the mycelium reaches a hair-follicle, it immediately sends a branch down it, which, according to Dr. Thin, develops with great luxuriance till it reaches nearly to the root of the hair-shaft, when it penetrates into the hair and grows upward in the substance of the hair, freely developing spores in every direction.

The consequence of the growth of the fungus in the hair-follicle is the production of a distended condition of the epidermis around the hair at its exit from the follicle. The hair looks as if it grew out of a little cone. This is a very characteristic appearance.

The action of the fungus on the hair itself is to disintegrate and dissociate the closely-cemented cells of which the hair is composed; the hair becomes lusterless, loses its elasticity, bends or twists in any direction, and at length breaks away, leaving a little stump projecting from the above-mentioned cone on the skin, and these little ragged stumps are again very characteristic of the disease. The microscopic appearance of the hair is also very characteristic, the whole hair being loaded with chains of conidia, which, however, need to be brought into view by first clearing the hair with a drop of liquor potassæ. The mycelium is not usually visible, although we know it must be there; but if the potash is allowed to act for some time (say half an hour or more) it will be brought into view. In diseased hairs taken from black horses and treated to this long-continued soaking in potash, the mycelium, and even the spores themselves, are often found to contain black pigment absorbed from the hair.

Now, although the fungus is never found in the softer parts of the skin, yet, as I have already said, it splits up those tissues it does live in, absorbing one portion for its own nourishment, and leaving the rest as a foreign and morbid product. This gives rise to inflammation in the surrounding tissues, and sets up a new set of morbid processes. Hence we get effusion from the blood vessels in the *rete mucosum* and the connective tissue, and as a result small abscesses and superficial ulcerations. A milder result of the same irritant is to be found in the little vesicles or pustules on the surface of the skin already mentioned. This disease differs from favus in its course; it is first of all essentially a disease of youth, calves and young horses being especially subject to it; and secondly, as a result of this, it tends toward a spontaneous cure, although two, or even three, years may go by before this is accomplished.

MICROSPORON.—Of this fungus I have very little to say, as I have not been able to find any reference to it as affecting animals. It seems to be one of those blessings especially intended for man, and I only introduce it here for the sake of completing my subject.

The appearance on the skin is that of smooth brown spots, varying in size from a pin's head to the palm of the hand, occurring chiefly in the body, not so frequently on the limbs.

The epidermis at these spots is easily peeled off in branny scales, and this *dèbris*, if examined under the microscope, reveals the presence of the mycelium and clustered spores of microsporon. The fungus is situated on the most superficial layers of the epidermis, and although it tends to center itself around the hair-follicles, it has no destructive influence on the hair itself. The growth of the fungus is exceedingly slow, and it seems to give rise to little or no discomfort. Those who seek the advice of the physician do so generally, as one writer says, purely for cosmetic reasons.

As it is a disease confined to adults, being found neither in the very young nor in the very old, there may be some reason in this observation.—*International Journal of Microscopy and Natural Science.*

SELECTIONS.

THE ORIGIN OF ORGANIC FORMS.

JOSEPH LE CONTE.

It has been truly said that in order to criticise any theory profitably, it is necessary, first, not only to understand it, but to sympathize with it. It is certain that Mr. Keep * has not been able to place himself at the standpoint of modern thought on the subject of evolution. His point of view is pre-Darwinian. His objections have been already discussed and disposed of. I cannot, therefore, take up these difficulties seriatim. All I can do is to clear up some fundamental misconceptions concerning the origin of life and the origin of species.

The theory of evolution is not conditioned, as many suppose, on its ability to explain the origin of life; to imagine so is to misunderstand the true function and domain of science. The domain of science includes only *secondary* causes or processes by which things come about. Or, if we like it better, we may define it as the modes of operation of the First Cause. We trace these processes as far back as we can. If we find a limit, that does not invalidate the previous explanation; nor have we any reason to conclude that where our knowledge stops, natural processes stop also, and supernatural methods begin. Suppose we accepted the earth as it now is, and knew nothing of how it became so; still there would be a science — physical geography — which studied the laws of its forms and forces. When we learn that the earth has gradually, through an immense lapse of time, become what it is, then we study the laws of this gradual becoming, and we have the science of geology. We may be able to go no further; we may not be able to imagine, even, how the earth originated, but this does not invalidate the science of geology; nor do we imagine that because our knowledge ceases, natural processes cease also at this point.

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* Doubts Concerning Evolution, Literary Digest, Vol. III., No. 16, p. 431.

So it is in the matter of the theory of evolution. The fact of not being able to explain the origin of the different primal forms, does not invalidate our reasoning; neither do we suppose that because we cannot explain the supposed primal forms, they came by miraculous process. By profounder study and greater knowledge, we now see reasons for tracing the organic kingdom back to one primal living form of simplest structure. How this primal form originated, we do not know and cannot imagine; still we conclude that it came by a natural process.

But the essayist assumes (1) that it did not come by natural forces and a natural process, for the same forces would produce similar results now; but this never occurs, therefore the origin of life must be supernatural; and (2) if the origin of the first life was supernatural, then it is probable that the origin of each subsequent kind of life (species) was also supernatural.

To the first of these propositions — it is true that every attempt to generate life *de novo* has failed. I believe it will always fail. But the complexity of the problem is so great that any number of failures is not sufficient to convince us of its impossibility. It is evolution itself that makes its impossibility certain. Evolution does not go backward, and begin again at its starting point. It moves ever forward, in some direction. In evolution, golden opportunities come but once. For example, supposing man originated by evolution from some lower form of animal; if he were to-day destroyed, there is no possibility that he would be re-formed by evolution from any existing animal. No existing form of animal is on its way manward. So also, supposing life to have originated from dead matter, and physical or chemical forces; if life were swept away to-day from the face of the earth, there is no possibility that it would be relighted by any natural process, *i. e.*, it would not be relighted at all. The golden opportunity of favorable conditions is past forever. The conditions under which so wonderful a transformation could take place are so complex that they could occur but once in the history of a planet.

Nor is this law peculiar to the living kingdom. The same is true of the inorganic world. The formation of elements, even by natural process, can take place but once in the history of a planet.

As to the second proposition, *viz.*, that if life originated by supernatural process, then, also, all subsequent transformations of forms of life were also supernatural; we would ask the essayist to push this proposition to its logical conclusion. He doubtless believes that matter originated by supernatural means; therefore, according to his logic, all subsequent transformations of matter are also by supernatural means. On this view what becomes of our science?

The essayist says that the conclusions of evolution are so contrary to common experience, that the intelligent mind hesitates to accept them. This is a most extraordinary statement. Does he mean that the miraculous origin of species is most in accordance with common experience? Are there any forms of any kind, organic or inorganic, living or dead, that did not, as far as we know, come by a gradual process of transformation? Soil was once supposed to have been made at once as a clothing to cover the rocky nakedness of the newborn Earth, and to afford a foothold for plants. Now we know that soil is naught else than the result of the rotting down of rocks. In fact, all inorganic forms, without exception, and all organic forms so far as common experience extends, came by natural process. Not a single case ever fell under common experience in which any form, organic or inorganic, living or dead, came by any other process than a natural one.

Mr. Keep has been able to cull some hard nuts for evolutionists to crack. The elephant and the whale are acknowledged to be extreme types, the origins of which are very obscure: some steps of the transformation are indeed known, still many gaps remain. But is the theory of miraculous creation any better or half so good in this regard? Remember that science is a study of processes. Is it not evident that any natural process, however strange the result, is more scientific, more in accordance with common experience, than a supernatural origin? —*Literary Digest, Vol. III., p. 13.*

THE AMŒBA OF DYSENTERY.

The existence of large amœbæ in the stools and mucous membrane of the lower gut of dysenteric patients, is known to us in Germany mainly through the researches of Osler in America. In Egypt, Kartulis independently described the presence of these micro-organisms, and now in Russia, Greece, and Bohemia other observers have confirmed their results. And not only in true dysentery, but, as Osler was the first to point out, in the hepatic abscesses complicating the chronic disease, are the amœbæ to be discovered, a fact which is against those who look upon the amœbæ as unassociated with dysentery, and as but harmless and common intestinal parasites.

In his latest paper Dr. Kartulis* announces that he has been able to carry our knowledge of the pathogenic properties of these micro-organisms several steps further; for not only has he been able to obtain pure cultures, but he has to a certain extent followed the development, and what is more, has been able to reproduce the disease in other animals by rectal injections of the pure culture, and to discover, after inoculation, numerous amœbæ in the evacuations, from which before inoculation they had been absent. Doubtless, the climatic conditions at Alexandria are unfavorable to exact bacteriological observations, and it is hard not to wish that many of Dr. Kartulis's methods had been less haphazard; nevertheless, the frank acknowledgment of his numerous failures tends to make acceptance of his successful results in some respects the more easy. By good fortune, rather than precise method, he would seem to have gained pure cultures, and with these he managed to inoculate.

According to him, the amœbæ from dysenteric stools will grow and multiply in very dilute broth, although a more satisfactory medium is a filtered and sterilized decoction of straw — ten to fifteen grams of straw to the liter of water, boiled for fifteen minutes, and filtered. In this the bacteria of the feces do not multiply too rapidly, and hinder the development of the amœbæ. The optimum temperature is between 30° and 38° C. Kartulis left the inoculated vessels unplugged; for he found that without free access of air, growth was delayed. [It would have been preferable to employ some method such as that of Fernbach, whereby a stream of sterilized air can be passed over the growing cultures.] By the above method, or again, by employing drop cultivations, he found that in twenty-four to forty-eight hours numerous minute organisms were to be seen, much smaller than the amœbæ of the stools, but possessing each a nucleus and vacuoles, and though putting out no pseudopodia, having a rapid "swarming" motion. By the fourth or fifth day, these developed into large amœbæ, with definite pseudopodia. In among the mass of these were to be seen small, motionless bodies, about the size of a white blood corpuscle, which eventually gained a double contour, and presented the appearance of spores. Their number constantly increased, so that by the tenth or eleventh day they were present in large quantities, while the amœbæ had become scarce. Taking now a drop of the medium containing the "spores," and placing it in a small amount of dilute broth, the organisms developed in this new medium into typical amœbæ. By intra-intestinal injection into guinea-pigs and rabbits, either of dysenteric evacuations or of the cultures of the amœbæ, Kartulis obtained no results.

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* "Einiges über die Pathogenese der Dysenterie-Amœben."— *Centralblatt für Bakteriologie*, Bd. IX, p. 365, March, 1891.

With dogs also he was unsuccessful, although dogs would seem to be liable to the disease, and he has had one under observation suffering from typical dysentery whose evacuations contained almost pure cultures of the organism. Lösch, on the other hand, by means of rectal injections, succeeded in setting up the malady in one out of four dogs thus operated upon. Possibly, as Kartulis suggests, race may be a factor to be considered. With cats, however, he was generally successful, whether he employed rectal injections of the pure culture, of impure cultures, or of dysenteric evacuations.

Turning to another side of the question, he could not produce dysentery by inoculations of pure growths of other micro-organisms found in the stools of patients suffering from the disease, and inoculations of the fluid evacuated, freed from amœbæ by filtration through flannel, was ineffective; nor, again, was he successful with pure cultures of the bacillus isolated by

Chantemesse and Widal from dysenteric stools, and considered by them to be possibly specific. Further, feeding the animals with growths of the amœbæ had no effect.

All these results require confirmation before they can be accepted; and especially is further information wanted upon the nature of the spore-like bodies. What is their relation to the amœboid form? It is difficult, from the account given, to look upon them as resting-stages of the whole amœba, and yet it seems highly improbable that they are produced endogenously.— *The Medical Chronicle, May, 1891.*

WHAT ARE BACTERIA?

Bacteria are not insects or "bugs," but plants; they have, however, the power of spontaneous motion. Like other living things, they take in matter and potential energy, and give off matter and manifest energy. In common with all vegetables not possessing chlorophyl, they require organic food for the maintenance of life; but they can subsist on food that contains no proteid, being able to take nitrogen and sulphur from inorganic sources, and with carbon from organic sources, and water, build up proteid material. They share respiration in common with all living things, taking in oxygen and giving off carbon dioxide. Certain bacteria, however, do not require free oxygen, being able to unlock it from the substances in which they exist; and certain chemical processes attributable to them evidently depend upon this power of unlocking oxygen from stable compounds.

Bacteria are very widely distributed, being present in the atmosphere in vast numbers, and also existing in earth and water. They cover the surface of our body, and line our entire alimentary canal. These micro-organisms are among the smallest objects which the microscope reveals. A very common form of bacteria is that known as the bacterium termo, which is an elongated, rod-like cell about one twenty-five thousandth of an inch in breadth, and less than twice its breadth in length. It is non-pathogenic, easily killed by antiseptics, and is always found in putrefying or septic fluids; hence it is sometimes called the carrion, or septic, fungus.

The living bacterium may be described as a simple "cell." Like other cells, it is composed chiefly of protoplasm, and has a distinct cell-wall, but no apparent nucleus. The protroplasm is of its usual composition, and may or may not contain vacuoles; the cell-wall is composed of cellulose.

From the forms presented, bacteria have been divided into three general groups. First, we have the sphero-bacteria, or micrococci (*coccus*, a berry), which are simply rounded or oval bodies, from one ten thousandth to one twenty-five thousandth of an inch in diameter. The non-pathogenic micrococci produce putrefaction, while among the pathogenic species may be mentioned those found in acute abscesses, boils, erysipelas, gonorrhœa, acute necrosis, osteo-myelitis, septicæmia, and pyæmia. Secondly, the bacilli (little rods) are, as the name implies, rod-like bodies of more than twice their breadth in length. They may be straight, or bent or curved in one direction. A bacillus with a single curve is spoken of as "comma bacillus." There are many pathogenic bacilli; those of surgical interest are the anthrax bacillus, the bacillus tuberculosis, the bacillus of glanders, of leprosy, of syphilis, of tetanus. The third variety, known as spirobacteria, consists of rods bent or curved in more than one direction, representing spirals and the like. The outer surface of the cell-wall of the bacteria is indistinct and ill-defined, being usually surrounded by a jelly-like substance known as zoöglia. By this they are often united in masses or chains.— *Chemical News.*

A BACTERIA-KILLING GLOBULIN.

In due course of his investigations upon the proteid bodies which act as factors in the production of immunity, E. Hanbury Hankin * has passed from the study of the albumoses developed by the growing (anthrax) bacilli to that of the globulins developed by or present in certain organs of the body, and he shows that these play a most important part in the combat between the organism and the microbe. In the first place, taking the lymphatic glands of cats and dogs, Hankin extracted from them (by treatment with sodium sulphate and alcohol) a body identical with Halliburton's cell-globulin *B*. This substance Halliburton believed to be fibrin ferment, or else inseparably connected with it. That the supposition is incorrect is shown by the fact that Lea and Green have obtained solutions apparently of fibrin ferment which caused the blood to clot rapidly, but which did not respond to the most delicate proteid tests. And what is more, this globulin possesses a property not held by fibrin ferment, namely, the power of killing anthrax bacilli. For if the bacilli be added to a solution of the globulin, and gelatine plate cultures be made with drops of this after successive periods of interaction, it is found that, thanks to the proteid, the number of colonies developing in the gelatine tests rapidly diminishes, that is to say, many of the bacilli originally added have been killed.* Indeed, if the bacilli added have not been in too great quantity, all may eventually be destroyed; and whereas a drop of the mixture taken immediately after it was made, gave, for example, 14,978 separate growths upon gelatine, after the bacilli had been subjected to the action of the globulin for two hours, a similar drop gave not a single growth.

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* Proceedings of the Royal Society, Vol. 48, 1890, p. 93.

Boiling this cell-globulin destroyed its germicidal power. If the solution was very dilute, the diminution occurring at first in the number of colonies upon the plate cultures was succeeded by an increase, showing that the bacteria-killing substance loses its power in the act of inserting it.

Muttall, Buchner, Nissen, and Lubarsch have found an exactly similar relation to hold good for blood-serum. And, as Lubarsch found in blood-serum, so here, anthrax spores were apparently unharmed, and produced vigorous crops. Hence Hankin concludes that the germicidal action of blood-serum is due to this same or some allied substance, and he is supported by Buchner's observation that dialysis of blood-serum into distilled water destroys, while dialysis into normal salt solution does not destroy, its bacteria-killing power. This is a clear indication that there is a globulin, since such a body would be precipitated by dialysing away the salts that enable it to be dissolved.

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* Report on the Conflict between the Organism and the Microbe -- *British Medical Journal*, July 12, 1890.

Continuing his researches into these "defensive proteids," Hankin next studied them in the rat, an animal peculiarly insusceptible to anthrax. The blood-serum of this animal possesses strong bactericidal powers as against the anthrax bacilli, a power which Buchner has ascribed to an, as yet, unisolated serum albuminate, and Behring to its high degree of alkalinity.* As Hankin shows, both these views are right, up to a certain point; for he has been able to separate out from the rat's spleen, and to detect its presence in the blood, a form of proteid which possesses characteristic alkaline reaction. At least three proteids are already known having such a reaction, and all these are albumoses,—the protomyosinose and deuteromyosinose prepared by Kühee and Chittenden from myosin, and Sidney Martin's solution of anthrax albumoses, which after prolonged dialysis still remained alkaline. It may be noted in passing that the boundary line between albumoses and globulins seems to be becoming so indefinite that no great stress need be laid upon the fact that the proteid from the rat's spleen is of the latter class.

Hankin determines that —

1. From the rat's spleen and serum a basic substance can be obtained which differs from other known bases in that it is insoluble in distilled water and alcohol, and in that it does not dialyse.

2. This substance is of proteid nature, and belongs to the globulins, though it differs from the majority of the globulins in the fact that precipitation by alcohol does not render it permanently insoluble, and that its solutions are alkaline.

3. This globulin has bactericidal properties, and to it is due the bactericidal action of the rat's serum.

4. Probably the immunity of rats toward anthrax and diphtheria is wholly or in part due to the capacity of the rat's organism to produce this substance.

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* "Ueber den Schützenden Eiweisskörper der Ratte." — *Centralblatt für Bakteriologie*, Bd. IX. 1891, Nos. 10, 11.

5. Not only outside the body, but also within the organism, this substance can exert its bactericidal power. He was able in certain mice to ward off the evil consequences of inoculations of anthrax cultures by injecting solutions of the globulin. It must be added, however, that with these animals, which are as susceptible to anthrax as rats are insusceptible, he was not completely successful. More work requires to be done before it can be said that this globulin can be employed as a certain cure, even in early stages of the disease.

Nevertheless, this does not diminish the importance of these observations in the further light they throw upon the causation of immunity. If they do nothing else, they tend to reconcile the two main opposing schools, that of Metschnikoff, which looks upon the bacteria as being destroyed within the cells; and that of Nuttall, Nissen, and Büchner, which considers the destruction as taking place almost wholly in the blood-serum and fluids of the body; for these globulins are evidently elaborated within what may be termed facultative phagocytes, and their appearance in the blood-serum would seem to be due to the breaking down of the white corpuscles, a process which we well know is continually taking place.— *The Medical Chronicle.*

THE GERMS OF TYPHOID FEVER.

The lectures delivered at the post-graduate course at Toronto last winter, have reached us in pamphlet form. Among them is one by Prof. Victor C. Vaughan, under the above caption. After reviewing the work which has been done by various investigators as to the presence of the Koch-Eberth germ in typhoid fever, and the attempts to inoculate lower animals with it, he sums up as follows: —

1. A germ giving the tests supposed to be characteristic of the Eberth germ is found invariably in the bodies of those dead from typhoid fever.

2. It has been isolated, and grown in pure cultures.

3. All attempts to induce typhoid fever in the lower animals by inoculation with this germ, have so far been without success.

4. Experiments show not only that the germ fails to multiply in the lower animals, but that, when introduced by inoculation, it soon dies.

The failure of the inoculation experiments may be due to insusceptibility on the part of the lower animals, or the germ employed may not be the cause of typhoid fever.

Huguenin, as quoted by Murchison, says that enteric fever with characteristic intestinal lesions is by no means uncommon among cattle in Switzerland. In 1882, Brautlecht inoculated rabbits with germs from water supposed to be the cause of a typhoid epidemic, and produced in them a wasting febrile disorder lasting from two to eight weeks, with the post-mortem evidences of severe catarrh of the small intestine. The intestinal walls were thickened and friable ; the mucous membrane swollen, yellowish, and reticulated ; ulceration was present in some cases, but was generally confined to individual glands. There was marked enlargement and coloration of the spleen and mesenteric glands. In 1885, Semmer reported typhoid fever in three dogs and a horse, in which the lesions were well marked. From this it would appear that the disease probably occurs in the lower animals, and the failure of the inoculation experiments cannot be explained by assuming the contrary.

Vaughan's own work on the subject is of value, particularly as to the sufficiency of the identification of the Koch-Eberth bacillus. The Koch-Eberth germ is said to be identified by its resistance to stains, and by its invisible growth on potato.

Two germs which Vaughan has frequently found in drinking water, and which he designates as bacillus A and bacillus B, are under ordinary circumstances very readily distinguished from the Koch-Eberth germ. But Vaughan grew these germs on healthy human spleen, at temperatures of 39° C. to 40° C. (102.2° F. to 104° F.), and made cultures from them from time to time. After seven days, bacillus A was so modified that its growth on potato could not be distinguished from that of the Koch-Eberth germ. And after fourteen days, it did not take stains even as deeply as the Koch-Eberth germ. Similar results were obtained from bacillus B.

Rodet and Roux, in 1890, found that the bacterium coli commune, when cultivated at a temperature of 44° C. to 46° C., acquired a close resemblance to Eberth's germ.

Vaughan concludes that we must abandon the belief that typhoid fever is due at all times to one and the same germ, which can be recognized by certain peculiarities in staining or in manner of growth.

Whether this conclusion will be generally admitted or not, we must agree that the experiments of Vaughan and those of Rodet and Roux show that the characteristics by which it has been sought to recognize the Koch-Eberth germ, can be acquired by some other germs by exposure to continuous high temperature, that is to say, to fever temperature. These experiments do not show, however, that the germ originally described by Eberth was not the cause of typhoid fever, although they throw doubt upon, in fact almost render valueless, observations relating to the germ, which have included as their means of recognition its peculiar growth on potato and its relation to staining agents.

It would seem also that it has not yet been shown beyond doubt that the lower animals are the subjects of true enteric fever. — *Jour. Am. Med. Ass'n.*

AN EARLY PROOF OF THE VALUE OF VACCINATION.

A CORRESPONDENT of the *British Medical Journal* sends to it the following extract from a French newspaper of October 3, 1804: "Six black children, the first who had ever been vaccinated at the island of Rèunion, and from whom 5,000 people were vaccinated, were shipped on board the vessel "Jeune Caroline," bound for one of the Seychelles Islands, to perform quarantine for smallpox. The six children were three months on board the ship, eating, drinking, and sleeping with the sick; during the time of quarantine they were inoculated with the virus taken from the pustules of the diseased passengers, by large incisions made on both arms. From the report made at the time and communicated to the Central Society of Vaccine by the Minister of the Home Department, it was found that, although these six children had slept under the same blankets, and in contact with the pustules of the sick, eating and drinking out of the same vessels, and having been inoculated with pus from the patients who ultimately died of the disease, they were all preserved from the contagion, and were during the whole time in perfect health. The proof and counter-proof is one of the most severe tests ever performed, and ought to have a marked place in the history of vaccination. The fact that six children lived in perfect health on board a small ship infected with smallpox, having on board twenty blacks with confluent smallpox, six of whom died, twenty to twenty-five others with dry crusts all over the body, with seven deaths before their arrival at the quarantine station, all packed in a small space between decks, is perhaps the most crucial test ever witnessed of preservation by vaccination."

KLEBS-LŒFFLER BACILLUS AND DIPHTHERIA.

PROF. E. KLEIN * has worked out the connection between the Klebs-Lœffler bacillus and diphtheria, like Zarniko, Escherich, Lœffler, Roux, and Yersin. He believes this is the sole cause of diphtheria. In twenty-two acute cases, he has found a bacillus invariably present (bacillus No. 2). In twelve cases a second bacillus was found (bacillus No. 1). The two organisms are much alike in their morphological and biological characters, but he considers that No. 1 is the Klebs-Lœffler bacillus.

Cats were inoculated with cultures obtained from human diphtheritic membrane. Two of the inoculated animals died on the sixth day. The reason he selected cats for the experiment was, that in families where diphtheria had occurred, cats have been known to be attacked by a disease similar to diphtheria, and in some cases the animals died. Cats are well suited for the experiments according to Klein. In the second article, Prof. Klein calls attention to epidemics of diphtheria in England, which have had their origin in milk containing diphtheria organisms. Three of these epidemics have occurred in recent years, in 1886, 1887, 1888. In each of these cases the cause is suspected to have been in the milk. In two of the suspected animals, eruptions were found on the udder and teats.

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* Centralblatt fur Bakteriologie und Parasitenkunde, Vol. VII., p. 489, 521, 785.

To determine whether diphtheria could be produced in cows, two animals were selected for experiment. They were inoculated subcutaneously on the left shoulder eight or ten weeks after calving. Each animal received 1 c cm. of the pure culture of the diphtheria bacillus. Two days after the inoculation, there was a slight swelling of the parts where the inoculation had been made; this increased in size for two weeks, when it became smaller; at this time the animals began to cough. Cow No. 1 lost its appetite; and cow No. 2 continued to eat till the twenty-third day, when it also lost its appetite. The animal became so weak that it could hardly stand. It was killed on the 25th day. Prof. Klein lays stress on the fact that it was possible for him to demonstrate the presence of the bacillus in the milk. Sections as well as culture made from the membrane and diseased tissues, showed the Lœffler bacillus. The eruptions found on the udder were of a contagious nature, since the contents were used to inoculate calves, with successful results.

MODE OF ENTRY OF THE TUBERCULAR POISON INTO THE BODY.

Dr. Bollinger believes that the frequency of infection through the skin has been underestimated. Several cases have been recorded of direct inoculation by wounds received from broken spittoons, by bites, operations, ear-rings, etc. Eczema and impetigo increase the susceptibility of the skin. No case has as yet been attributed to vaccination, and it would appear that the tubercle bacilli are unable to live in the vaccine lymph. They also appear unable to pierce the pores of the skin, as do some of the pyogenic organisms. The susceptibility of the mucous membranes is increased by inflammatory processes, such as otitis, rhinitis, conjunctivitis, and pharyngitis. The poison travels to the submaxillary glands and those of the neck, and generally causes local tuberculosis of the glands. The chief point of infection is of course the lungs. Local predisposition is best exhibited by apices which have been before diseased, but have undergone a healing process.

As regards primary tuberculosis of the testicles, joints, and bones, Bollinger considers that a latent hematogenic infection must be understood, which leaves as little trace of its point of entry as does a primary septic endocarditis or an osteo-myelitis. Tubercular disease of the larynx depends upon an auto-infection through the sputum. The rarity of this disease in children is explained by the infrequency of pulmonary cavities in the rapid forms of phthisis. Primary tuberculosis of the intestine generally, combined with an affection of the mesenteric and retroperitoneal glands, is usually occasioned by means of vitiated food and contaminated feeding utensils. Secondary tuberculosis of the intestine depends upon an auto-infection. The tubercular poison passes through to the intestine unaltered by the juices of the stomach, and attacks the Peyer's patches and solitary follicles. Tuberculosis of the peritoneum, which is two or three times as common in men as in women, can arise directly from ulcers of the intestines, from tubercular abdominal glands, or especially in women, from the urogenital track; further, through contagion from the lungs and pleura, and finally in the course of miliary tuberculosis, or from caseous bronchial glands. Primary tuberculosis of the peritoneum is quite rare. As regards the infection from milk, this is, in Bollinger's opinion, undoubtedly due to the udder of the cow being affected with the disease. Infection through the milk of tuberculous women has not yet been proved.— *Münchener Medizinische Wochenschrift.*

ON THE PRESENCE OF PSEUDO-MICROBES IN NORMAL BLOOD.

According to the experiments of M. Kolmann, given in the *Journal des Sociétés Scientifiques* for September 24, 1890, the following microbes are found in normal blood: —

1. Round or elongated punctiform elements not larger than one micromillimeter in diameter, which may be agglomerated in diplococci, streptococci, bacilli, etc.

2. Larger organisms, spheroidal or oval in shape.

3. Corpuscles with filiform prolongations analogous to those found in malarial poisoning. Very often they are seen to exhibit active movements.

According to the author, the pseudo-microbes originate mostly from the red blood cells, but probably also from the leucocytes and hæmotoblasts. An attempt to detect them by means of staining agents, as well as that to produce a culture, proved them not to be microbes. M. Gualdi, of Rome, found these pseudo-microbes in three hundred cases of malarial disease. He found, however, the same in the blood of apparently healthy persons. — *N. Y. Medical Journal.*

THE POWER OF RESISTANCE OF THE HOG CHOLERA BACILLUS.

According to Dr. Theobald Smith * the hog cholera bacillus is distroyed instantly when placed in 10 cc. m. of beef bouillon at 100°C.; at 70°C. they are destroyed in four minutes; at 58°C. they are destroyed in fifteen minutes; at 54°C., in sixty minutes; at 49°C., they are still alive ofter two hours. Corrosive sublimate in the proportion of 1 : 100,000 destroyed the organism in thirty minutes. Iodide of mercury, dissolved in two parts of iodide of potash in the proportion of 1 : 200,000, destroyed the germs in two minutes; 1 : 1,000,000, in ten minutes: sulphate of copper, 1 : 200, in five minutes; 1 : 1,000, in twenty minutes: carbolic acid, 1 : 100, in from five to ten minutes; chloride of zinc, 1 : 10, in fifteen minutes. — *Vis. Medicatrix.*

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* Centralblatt fur Bakteriologie und Parasitenkunde, Vol. IX., p. 308.

EDITORIAL.

REVIEWS, ANALYSES, DIGESTS, ETC.

THE BACTERIOLOGICAL WORLD'S NEW HOME: THE SANITARIUM LABORATORY OF HYGIENE.

As announced in the last issue, henceforth the BACTERIOLOGICAL WORLD will be published at Battle Creek, Mich. The editor has taken charge of the Sanitarium Laboratory of Hygiene, and will devote his time and energies to the cause of the sciences relating to life, health, and disease.

In the September number of *Good Health* (Publishers' Department) may be found stated the object and scope of this new scientific institution. I quote from this discription: "The Laboratory will be sub-divided into a number of departments as follows:—

"*A Physiological Laboratory*, in which will be studied the various vital functions of the body, which are capable of experimental study. The subject of digestion will receive special attention.

"*A Bacteriological Laboratory*, in which will be cultivated and studied, all known forms of bacteria, or germs. The relations of bacteria to food, water, air, and contagious diseases, will be studied with minute care, and by the aid of all the resources afforded by the most recent and reliable researches upon this question.

"*A Pathological Laboratory*, in which special study will be made of diseased conditions, and the causes of such diseases as consumption, cancer, and other grave maladies.

"*A Chemical Laboratory*, a necessary supplement to the work of the other departments of the laboratory.

"*A Vaccine Laboratory*, in which will be produced the means of protection from smallpox, hydrophobia, etc."

This will only be done on a scientific basis, and not with a view to commercial aggrandizement. The object sought is the improvement of the protective vaccine virus of smallpox chiefly, *i. e.*, vaccinia, the commercial products of which usually contain numerous pus-producing and septic micro-organisms, which are directly responsible for the variety of septic symptoms commonly following vaccination. The production of absolutely pure vaccine lymph, free from any kind of foreign germs, will remove one of the most telling objections to vaccination.

The editor has had several years' experience as a vaccine propagator, and has made numerous observations and extensive experiments with various products; and he hopes to place before the vaccine producers of this country, and the medical world at large, means by which absolutely pure vaccinia may be put at their disposal. The supply of the laboratory itself will be limited, allowing only such quantities in the hands of the profession as will best afford the accomplishment of our purpose.

It will be seen, from this brief outline of the scope of our laboratory, that we shall institute researches in a broad and varied field, offering unlimited room for advancement and expansion in a scientific sense. It is not expected, therefore, at once to have each department in perfect working order; this will be the work of years; we shall gradually train men for each department. But we shall be ready within a month to prosecute researches of vast importance to the medical profession and the people.

THE BACTERIOLOGICAL WORLD will be the scientific organ of the laboratory; in its columns will appear, first, the result of the laboratory's work. It is hoped thereby greatly to increase the value of this Magazine. We feel sure that our friends and the medical fraternity will appreciate the new condition of things, and give us a helping hand in the way of subscriptions.

WE had underestimated the trouble of removing ourselves, our little possessions, and our humble plant, from the seat of the University of Missouri, Columbia, Mo., to the Sanitarium, Battle Creek, Mich., and we hoped to have ample time to get everything in proper shape so that the BACTERIOLOGICAL WORLD should continue to publish its monthly lessons in bacteriology. We regret to say that we have been disappointed; we must go to press under difficulties, for this first issue in our new home; and in order to appear in September, we must print at once, without the lessons of August and September. We know that much more valuable matter from the pen of others in this issue will make the loss imperceptible; and for the sake of those who have taken the Magazine for the benefit of these lessons, we shall make it up in the subsequent issues of 1891, even at the cost of increasing the size of each number, if necessary.

SOME changes in appearance and style will be noticed in this issue. This is the work of evolution, which ever goes onward toward perfection. We propose to present our readers with matter under a smaller number of headings, and in a simpler and more comprehensive way.

TOXALBUMOSE OF A MICROBE OF BLENNORRHAGIC PUS.

MESSRS. HUGOUNEUQ AND ERAND presented a note to the Academy of Science, Paris, July 20, concerning a poisonous albuminous substance generated by a coccus of blennorrhagic pus, whose morphology and reactions resemble those of Neisser's gonococcus; it does not liquefy gelatine, and does not decolorize by Gram's method. In a peptonized broth culture, it made its appearance in pairs and masses, and presented oscillating movements. Inoculated into the conjunctiva of dogs, rabbits, and guinea pigs, it was fruitless.

In precipitating seven liters of culture broth filtrated through porcelain, by twenty-one liters of alcohol at 93°, a solid matter was obtained; this substance, washed with alcohol, dissolved in water, and filtered again through porcelain, furnished an aqueous solution which, when treated again with alcohol, presented an amorphous yellowish white product very soluble in water, and with all the physical and chemical properties of albuminoids.

The pathogenic properties of this substance are very curious. They seem to be limited to the testicles. If deposited in the eye or the urethra of a dog, they remain harmless, but injected into the testicles of a young animal of this species, they cause a suppuration; the envelope of the glands perforate, and soon there is but a fragment of atrophied testicles. In aged dogs the phenomena are purely phlogogenic, and atrophy follows orchitis. Repeated experiments gave constantly the same results. Water, sterilized broth, and peptone were absorbed rapidly without causing any alteration.

In a culture broth of asparagine and ashes of meat, the microbe developes more slowly, and no poisonous extract could be extracted from it by the process above mentioned. The microbe then does not manufacture this phlogogenous matter irrespective of the nature of its food: in this instance the peptone of the broth seemed to furnish the elements necessary for the production of the tox-albumen. This product, however, has no diastasic action on fibrin.

Two interesting suggestions are presented by these experiments: 1. The fact that a particular poison of cellular vegetation is not inherent in the producer irrespective of the nutrition afforded; and 2. The specific action of the substance or testicular tissue may elucidate the pathology of blennorrhagic orchitis.

*METHOD OF PROMPT TRANSFORMATION OF TUBERCULOUS PRODUCTS AND TISSUES.**

BY B. M. LANNELONGUE.
Paris, France.

Four months ago I began upon man the first tests of a method of treatment of tuberculous products. During this time I have applied it to the diverse kinds of the tuberculous affection, the types in which the manifestations show with evidence the successive stages of its evolution, from the initial period of the infection, until the most advanced degrees, including the mortification of the tissues, or their very advanced decay.

I do not refer (such is at least my conviction) to a specific remedy specially and uniquely aiming at the bacillus, which it would destroy in a short time; I only mean a chemical agent, possessing special properties in regard to living tissues. This sufficiently powerful antiseptic agent is chloride of zinc, employed according to a particular method, of which I will specify the details later.

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* Read before the French Academy of Science, July 6, 1891.

The lesion that the bacillus tuberculosis produces being almost always localized in a place determined by the organism, it has seemed to me that it was in this place that all healing action should exercise itself with the most success; it also seemed to me that we would imitate in all points the natural work of cure, if we succeeded in transforming the fibrous tissue into a tissue representing the cicatrix or the healing process of almost all the organic alterations. In a word, the method has for its object the sclerosing of the tuberculous tissue, whatever may be its seat; it seeks the condition which seems the most opposed to the existence of the bacillus.

The method that I recommend consists in making the therapeutic agent penetrate not in the fungosities, nor in the tuberculous centers, but only around them and on the outside of them. The bacillary function is always accomplished eccentrically; the normal tissues, forming the limit of the morbid center, are as an unceasing elaborating matrix forming, under the incitation of the bacillus, the tuberculous neoplasms which propagate thus gradually by continuity of the tissue.

Hence the necessity of modifying, above all, the peripheric layer where the sowing begins; but it is also essential to perform the transformation of the layers infested with tubercles where the bacillus is fully at work. We must not forget, either, that the zone where the specific alterations exist, receives its vessels, that is to say, the elements of its nutrition, from the periphery continuing with it.

Experimentation shows that the chloride of zinc produces a remarkable fibroid transformation in the normal tissues of animals. We obtain the same effects on the altered tissues, particularly the tuberculous tissue. The medicine fixes, in killing them, the anatomical elements at the point where it is deposited, and even at a greater distance; it obliterates a certain number of capillaries and small vessels; it produces finally an inflammatory irritation of the vascular walls, which narrows the size of the arteries and veins to a notable extent, distant sometimes from the initial point.

But it produces at the same time a local modification far more important. Very rapidly, almost in a few hours, there appears in the depth of the altered tissues, by diapedesis and also probably by cellular proliferation, an enormous afflux of new anatomical elements. The sudden and intense irruption of the young cells takes place not only at the same point of application of the remedy, but also at a certain distance, by diffusion of the therapeutic agent; these cells surround and mix in the periphery of the fungosities, and largely infiltrate the tuberculous neoplasm.

The struggle begins, from this moment, between the gathered elements and the bacillus, particularly between the migrating cells and this agent, in view of absorbing and distroying it.

We can appreciate the formation of new tissue the very next day after the operation; its qualities become rapidly firm, if we had recourse to a solution 1 to 10. To the sclerosis of the articular fungosities is added a diffused osteoma under the periosteum, with bony condensation, if one has taken care to interest the periosteum in the work of reparation, as I generally do in most of cases of tuberculoses osteo-anthrites.

The ulterior evolution, so far as I can judge by my chemical results, shows a marked tendency toward the return of the sclerous tissues to a more loose conjunctive tissue. As a result, the parts recover their suppleness and form, and the locomotion finds itself preserved wholly, or at least in the limit in which it existed at the beginning of the treatment.

Permit me to say here, that in the first twenty-two cases, without exception, I have obtained a favorable transformation, which was expressed by the cure or a promising amelioration announcing early recovery.

All this points to the belief that a total transformation of a tuberculous tissue into fibrous tissue is scarcely compatible with the life of the bacillus. The constitution of the new tissue diminishes in all cases the sources of infection; for it is long since proven that the tuberculous centers, soft and impregnated with liquids or juice, are by far the most dangerous for the neighboring regions and the entire system. Therefore, if the bacillus persists in the sclerous tissues,— a question that we seek to solve experimentally, while awaiting proofs drawn from the examination of the anatomical pieces,—it seems to be confined in a place where it is as if encapsuled, and becomes inoffensive, all trace of its activity disappearing.

TECHNIQUE.

THE PREPARATION OF NUTRITIVE AGAR.

BY V. A. MOORE, M. D.,

Assistant in the Laboratory of the Bureau of Animal Industry, Department of Agriculture, Washington, D. C.

THE extent to which nutritive agar is employed in the cultivation of bacteria, renders it of much importance that its method of preparation should be made as perfect as possible. When it is prepared after the method recommended in works on bacteriology (which is practically the same as that first formulated by Koch for the preparation of solid culture media), a medium is obtained that favors the growth of most germs. In this respect the method is desirable, but in regard to the other requisites of a satisfactory solid medium, it is quite deficient.

The objections to the method with reference both to the process itself and the character of the resultant agar, are three in number :—

1. The difficulties attending the filtration of the agar. This process alone often requires a very considerable length of time, besides the use of a hot filtering apparatus, which must be provided especially for this purpose.

2. The presence in the sterile agar of a flocculent precipitate which is invariably thrown down during the process of its sterilization, and which greatly interferes with its usefulness, especially in making roll and plate cultures.

3. The variation in the consistency of the agar. It is impossible to obtain this material of the same consistency, as the agar is only partially dissolved, even after long boiling in the simple beef-infusion. The coagulation of the albumen ensheathes the stems of agar, and floats them to the surface, where they remain imbedded in the firm, albuminous coagulum. This property of the agar is worthy of consideration, for with the varying consistency of the medium, a consequent change follows in the character of the growth of most germs.

For the purpose of securing a process for the preparation of nutritive agar that was free from the above-mentioned difficulties, I have reviewed carefully the methods of Jacobi,* Von Freudenreich,† and Cheesman,‡ in all of which I found difficulties that were equally as objectionable as those possessed by the original method.

The use of a solution of beef-extract in distilled water, instead of the simple beef infusion made directly from the fresh meat, was also tried, but the agar thus prepared did not favor as vigorous a growth of many germs as when prepared from the fresh meat infusion. So feeble was the growth of many germs upon this agar that the method was abandoned, although very satisfactory in other respects.

In the course of this experimental work, it was found that when the stems of agar were cut into small pieces, and boiled in a fluid containing no coagulable material, it was entirely broken up, and the soluble portion dissolved. The insoluble particles that remained suspended in the liquid were easily and completely removed by the addition of egg albumen, and subsequent boiling and filtering. From these facts a method for the preparation of nutritive agar was derived, which consists in first preparing the neutralized beef infusion peptone, and thus getting rid of all coagulable material before the agar is added. This process is effective in greatly diminishing the time and attention required for the preparation of this medium. The medium can always be made of the same consistency, as all of the agar that is added is dissolved. It remains free from precipitates when sterilized, and its nutritive qualities are as favorable to bacterial growth as when it is prepared after the original method.

1. *The Preparation of the Beef Infusion Peptone.*— The method of preparing this liquid is practically the same as that already in use in most laboratories. Finely chopped or ground beef (freed from fat) is macerated in distilled water for from twelve to eighteen hours in a cool place. The distilled water is added in the proportion of 200 c.c. to each 100 grams of beef. On the following day the liquid is separated from the meat by straining it through coarse linen. The simple beef infusion thus obtained should be equal in quantity to the amount of water added; if it is not, the deficiency can be restored by the addition of distilled water. To the beef infusion is added 1 per cent peptone, ½ per cent sodium chloride, and if it is desirable to make it alkaline, a sufficient quantity of a normal solution of sodium carbonate, to give it a weak alkaline reaction. The liquid is then boiled for thirty minutes in a water-bath, cooled, filtered, and distributed in Erlenmeyer flasks plugged with cotton-wool. If only a small quantity of agar is to be made at once, 250 c.c. is found to be a very convenient quantity to put in each flask. It is sterilized by boiling for one hour each day for three consecutive days.

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* Centralblatt fur Bakteriologie und Parasitenkunde III. (1888), p. 538.

† *Ibid*, p. 797.

‡ American Naturalist, XXII. (1888), p. 472.

It need not be sterilized if it is desirable to prepare the agar at once. As the beef infusion peptone is also employed as a liquid medium in the cultivation of bacteria, very little time is lost in preparing an extra quantity of this liquid to be used in making the agar.

2. *The Preparation of the Agar.*—To an Erlenmeyer flask (a glass-beaker or an agate iron vessel may be used) containing beef infusion peptone, as prepared above, 1 per cent of *very finely chopped* agar is added. The flask is then placed in a water-bath, and boiled vigorously for two hours. At the end of that time the agar is all dissolved, and the liquid is allowed to cool. When a temperature of 40–45° C. is reached, the white of egg is added in the proportion of one egg to 250 c.c. of the liquid. After the albumen is *thoroughly* mixed with the liquid agar, it is returned to the water-bath, and again boiled for two hours. It is of much importance that the albumen be evenly distributed throughout the mass before it is coagulated. It is now ready to be filtered. The egg albumen is coagulated in very firm masses, leaving the liquid perfectly clear. The coagulum is removed by filtering the liquid through fine Japanese filter paper or a layer of absorbent cotton, as a 1 per cent solution of the agar does not pass readily through ordinary filter paper. Should a weaker solution of the agar ($\frac{1}{2}$ to $\frac{3}{4}$ per cent) be desired, its filtration can be accomplished by the ordinary method. A hot filtering apparatus is not necessary. The clear filtrate is now ready for distribution in sterile, cotton-plugged tubes.

The agar is sterilized by discontinuous boiling in a closed water-bath for three consecutive days. If small tubes have been used, containing not more than seven cubic centimeters each, five minutes' boiling each day is sufficient. If larger tubes are used, they should be boiled for a longer time. Or it may be sterilized by steaming each day for from five to ten minutes after the agar has become liquefied, for the same number of days. After its sterility has been tested by allowing it to stand in an incubator for several days, it is ready to be stored until required for use. It has been customary, in this laboratory, in order to prevent the evaporation of the agar by long standing, to dip the lower end of the cotton-plugs in hot sterilized paraffine, and to store the tubes in a cool, moist chamber.— *The American Microscopical Journal.*

A SIMPLE TURN-TABLE.

BY A. S. ELLIOTT.

Brooklyn, N. Y.

Procure the frame and running gear of any cheap clock. Fifty cents will cover cost of all materials. Remove the mainspring from its place, and make the wheel carrying it firm on the shaft. Remove all projecting parts from both top and bottom of frame. Reverse the center wheel, putting the larger end of shaft uppermost, and making all bearings tight and smooth without oil. Cut a brass plate (soft) three inches in diameter ; find center bore, then bore two more holes one and one-fourth inches from center ; make a pair of light-bowed springs, solder to nail fitting such hole, and fit tightly through plate, placing the clips in opposition to each other. Cut or scratch three concentric circles one-fourth, one-half, and three-fourths, turning table rapidly. Fit the center shaft firmly to plate without soldering.

The apparent disadvantage of using a cogged wheel in turning with the hand is more than counteracted by the greater ease and consequent steadier rotation, together with greater speed attained by this table. Carefully made, it will do as good or even better work than the ordinary form. If preferred, the clips may be soldered fast to the plate, but are rather unhandy.

The holes in the bottom of the frame can be utilized to secure a firm base, and the hand may rest in any convenient manner to suit the requirement of the maker. — *The American Microscopical Journal.*

CULTIVATION OF THE LEPROSY BACILLUS IN BLISTER SERUM.

Beaven Rake and G. A. Buckmaster, working in the Almora Leper Asylum and in the new laboratory built by the Indian government at Simla for the use of the Leprosy Commission, have succeeded in cultivating the leprosy bacillus in blister serum. Culture experiments were first begun on March 31, but these were without result. On April 14 a blister was raised over a tubercle on the face of a leper at Almora, and another over normal skin on the back of the same leper. Specimens of fluid from these blisters were taken in a sterilized capillary tube, and allowed to mix. Previous examination of blister fluid over a tubercle in this patient had shown leprosy bacilli. The capillary tube was kept at a constant temperature of 98° F. (36.66° C.), and was taken to Simla, where it was examined on May 2. There was then some turbidity of the liquid, and fuchsin showed some brightly stained leprosy bacilli. On May 14 a tube of bouillon was inoculated from this tube of serum, and on May 26 there was an undoubted growth of leprosy bacilli on the surface of the bouillon. From this culture secondary growths of leprosy bacilli were obtained on bouillon, agar, and gelatin. Another capillary tube of blister fluid, prepared in the same way from another leper, gave similar results.— *The British Journal of Dermatology.*

EXAMINATION OF MILK FOR TUBERCLE BACILLUS.

The following method has recently been recommended by a pharmacist, in *Monitore dei Farmacisti :* A drop of milk is placed on a cover-glass, to which is added two or three times its volume of a 1 per cent solution of sodium carbonate. The fluids are mixed with a platinum needle, then cautiously held over an alcohol-lamp or Bunsen burner till the water evaporates. During evaporation the fats are saponified, leaving a thin layer of soap on the cover-glass. The remainder of the work is as it is ordinarily done in staining tubercle bacilli. [See *Satellite,* February, 1890, page 122 ; also *ibid.*, March, 1891, p. 129.] — *Vis Medicatrix.*

EHRLICH'S TEST IN TYPHOID FEVER.

This test, which has been known for a number of years, has till recently been regarded by many rather as a medical curiosity than as of diagnostic value. Dr. C. E. Simon, of the Johns Hopkins Hospital, has recently shown that by carefully following the precise directions for its use, valuable information may be derived.

The test consists of two solutions: 1. A saturated solution of sulphanilic acid in five per cent hydrochloric acid ; and, 2. A five per cent solution of sodium nitrate. These are to be mixed just before use, in the proportion of 40 cc. of the first to 1 cc. of the second. If this mixture be added to urine of a case of typhoid fever, the further addition of ammonia will produce a play of colors varying from an eosine rose to a deep garnet red.

The best method of applying the test is to take a few centimeters of urine in a test tube, adding an equal quantity of the sulphanilic acid mixture and shaking thoroughly; 1 cc. of ammonia is then carefully run down the side of the tube. At the junction of the two liquids there will be observed a ring of the characteristic color, which is produced in scarcely any other disease than typhoid fever.

Dr. Simon's conclusions may be summarized thus : 1. The reaction may be obtained in typhoid fever from the fifth to the twenty-second day of the disease ; 2. Its absence from the fifth to the ninth day indicates a very mild attack, save in children, although this rule is not an absolute one ; 3. As it occurs previous to the appearance of the rash, it is a very useful aid in the diagnosis of typhoid fever.-- *Therapeutic Gazette.*

LITERATURE.

HON. CARROLL D. WRIGHT will begin, in the October *Popular Science Monthly*, a series of papers under the title, "Lessons from the Census." In the first of these he sketches the changes in scope and methods which the United States census has undergone in the past hundred years, and shows that its immense growth has made it a somewhat clumsy machine.

The series of articles on "American Industries" in the *Popular Science Monthly* will be continued in the October number, with a fully illustrated account of "The Manufacture of Steel," by William F. Durfee, giving the history of the industry from colonial times to the introduction of the Bessemer process.

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NOTICES.

MICROCIDINE. — According to the *British and Colonial Druggist*, "the new antiseptic which Professor Berlioz, Grenoble, has invented, and which is at this moment receiving so much attention from the members of the French Academy of Medicine, is described as a compound of soda and naphthol, the latter, as is well known, being itself a powerful antiseptic. But it is claimed for the new substance that it is perfectly harmless, extremely soluble, and very much more efficacious than thymol, boric acid, carbolic acid, or any of the other antiseptics in general use."

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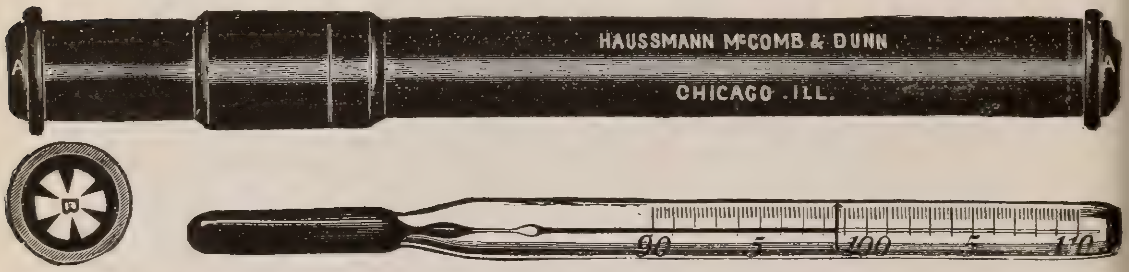

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NEW CONTRIBUTIONS TO SCIENCE.

*NOTES ON THE BACTERIOLOGICAL STUDY OF DIPHTHERIA.**

BY WYATT JOHNSON, M. D., MONTREAL.

MY original object in studying cases of diphtheria bacteriologically, was to settle the nature of a series of those doubtful cases in which a diagnosis is practically impossible by the ordinary means of observation, and where the occurrence of post-diphtherial paralysis or the outbreak of similar or more typical sore throats is the earliest positive proof of the true nature of the case. As I have found it impossible to continue the work

* Read before the Medico-Chirurgical Society of Montreal.

on account of the difficulty in obtaining clinical histories of the cases, I wish to publish the results obtained from the examination of another series of cases, most of which were capable of being diagnosed as diphtheria without much difficulty.

Some time ago I showed before this Society, cultures obtained from cases of diphtheria, in which the growth had presented the typical characters of the Klebs-Lœffler bacilli. The main characteristics of this organism are: —

1. Rapid growth in serum at blood temperature, leading to the formation of well-characterized colonies in sixteen to twenty-four hours.

2. Peculiarities of structure, especially the presence of involution, bacillus forms having clubbed or swollen ends, with granular, unevenly stained protoplasm.

3. Toxic effects, producing pseudo-membranous inflammations, followed by characteristic paresis, in cats and rabbits, and uniformly killing guinea-pigs in two to five days, when injected subcutaneously, with production of necrosis, surrounded by local inflammations and œdema at the site of inoculation, and usually associated with more or less marked parenchymatous degenerations and areas of cell-necrosis of the viscera. This condition is distinguished from other forms of experimental septicæmia by the fact that bacteria are absent from the blood and viscera.

These toxic effects are most striking, and serve to distinguish this organism absolutely from all other species of bacteria. They depend on the fact that the diphtheria bacilli generate an albuminous poison, or toxin, which, when absorbed into the system, produces fever, cell necrosis, and paralysis, which symptoms and lesions can be also brought about by the injection of sterilized cultures containing the toxin alone, without any living bacilli. The primary local lesions in diphtheria are probably due both to the toxic action of the poisonous substances evolved and the presence of the bacilli.

The disease diphtheria is therefore complex in nature; the presence of the local exudation of false membrane and the toxic constitutional effects being each a necessary part of all cases of true diphtheria. As the diagnosis is naturally based upon the local inflammatory appearances, and as diphtheria is by far the commonest cause of pseudo-membranous inflammations, the term *diphtheritic* has come to be applied to all severe inflammations attended with the formation of false membrane and accompanied by necrosis, while the term *croupous* is applied to milder inflammations where there is no necrosis. It should be borne in mind that the terms *diphtheritic* and *croupous* are of anatomical and not of ætiological significance, as the neglect of this distinction has led to a great deal of confusion. Diphtheritic inflammation is most often caused by the disease diphtheria, but is not by any means invariably due to this cause, since every sloughing inflammation of a mucous surface presents diphtheritic characters, and must be called, on anatomical grounds, diphtheritic. On the other hand, croupous inflammations have been shown by Paltauf and Kolisko to be sometimes the effect of the action of the Klebs-Lœffler bacilli, so that in this case we have a *croupous non-diphtheritic diphtheria.*

To prevent error, the terms *diphtheria* and *diphtheritic* should not be considered synonymous; and since the word *diphtheritic* has become too firmly established to be dropped from the vocabulary, it might be well if a suggestion of Dr. MacAllister* were adopted, and the word *diphtherial* used always to express ætiologically in relation to the specific cause diphtheria, applying the term *diphtheritic* simply in its more general anatomical sense.

There is evidence to show that cases occur in which an anatomically genuine diphtheritic sore throat may be caused by other organisms than the Lœffler bacilli. Roux and Yersin† record with great care several such cases, where the infection was due apparently to streptococci. Out of 80 cases of angina admitted to the diphtheria wards of the Children's Hospital, the bacilli were found in 61. Roux and Yersin had no scruples in classing the other 19 cases, in which no bacteria were found, as non-diphtherial angina. A much more remarkable series was that published by Dr. T. M. Prudden, where in 24 cases of diphtheritic sore throat occurring in children, streptococci were found in 22 and staphylococci aurei in 2, while the Lœffler bacillus was not met with in a single instance. It is important to note that these cases were obtained from an epidemic among children who were inmates of an institution in which scarletina and erysipelas were epidemic at the time.*

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* *Practitioner*, June, 1890.

† *Pasteur Annales*, July, 1890.

A subsequent series of 12 cases, all fatal, by the same author,† showed the presence of the virulent Lœffler bacilli in every instance; and a carefully prepared table appended, giving the total number of cases investigated in this manner by various authors up to date, shows that the Lœffler bacilli were found in 307 out of a total of 342 examined — about ninety per cent. The suggestion that the cause of diphtheria in America differed from that in Europe, had been previously disproved by Prof. W. H. Welch and Dr. A. C. Abbott, who, in a most exact study of eight cases of typical diphtheria occurring in Baltimore, found the Lœffler bacilli present in every instance.‡

That diphtheritic membrane can be produced among other causes by the streptococcus pyogenes, is shown by the uniform presence of this organism in the diphtheritic endometritis occurring in puerperal fever. The only statements as to the absence of the Lœffler bacilli in diphtheritis of other regions than the throat, is furnished by Paltauf and Kolisko, who were unable to find the bacilli in this condition or in intestinal or cutaneous diphtheritis phagædena.§

I have tabulated below the cases collected by Dr. Prudden, and added my own cases. (I have not included in this table the cases where I was not able to obtain satisfactory material for examination, as I found in cases A 2 and A 3 that the bacilli might easily be missed if the secretions only were examined, although found in portions of actual membrane.)

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* *Amer. Jour. Med. Sci.*, May, 1889.

† *N. Y. Medical Record*, April 18, 1891.

‡ *Johns Hopkins Hospital Bulletin*, Jan., 1890.

§ *Wiener med. Wochenschrift*, No. 8, 1889.

OBSERVER.	REFERENCE.	No. of Cases Examined.	Lœffler Bacilli.	
			Present in.	Absent in.
Babes	Zeitschrift f. Hygiene. Bd. 5	42	42	0
D'Espine	Revue Medicale de la Suisse, Romande, 1888, No. 1	14	14	0
Ortman	Berl. Klin. Wochen., 1889, No. 10	16	15	1
Spronck	Central. f. Pathol., Bd. 1, p. 218	7	7	0
Roux and Yersin	Annales de L'Institut Pasteur, Dec. 1888	15	15	0
Paltauf and Kolisko	Wiener Klin. Woch., 1889, No. 6	50	50	0
Zarniko	In Aug. Dissertation, Kiel. 1889	20	18	2
Beck	Zeitschrift f. Hygiene, Bd. 8	52	50	2
Sorensen	Nordiskt Medicinskt Archiv, Bd. 18, No. 25	10	7	3
Escherich	Cent. f. Bakteriologie, Jan. 2, 1890	22	20	2
Tangl	Cent. f. Pathologie, Bd. 1, p. 795	18	18	0
Briegn and Fraenkel	Berl. Klin. Wochen., Mar. 17, 1890	22	22	0
Prudden (1st series)	Am. Jour. Med. Sci., May, 1889	24	0	24
Welch and Abbott	Johns Hopkins Hosp. Bul., Vol. 2, No. 11	8	8	0
Prudden (2nd series)	N. Y. Med. Record, April 18, 1891	12	12	0
Johnston	Montreal Med. Jour., Sept., 1891	10	9	1
		342	307	35

The method of examining is very simple, and no one having an elementary training in bacteriology would have any trouble in carrying it out. Following the directions of Roux and Yersin,* I employed sterilized serum, obtained either from ox blood or from hydrocele or pleuritic exudation. I can quite confirm the statements of these observers as to the advantage of this medium over agar-agar jelly, since by employing serum the colonies of the diphtheria bacilli are readily recognizable at the end of twenty hours, or even earlier if the serum be "improved" in the manner recommended by Lœffler, through the addition of one fourth its bulk of a broth containing peptone, beef-tea, and sugar. On the other hand, if agar-agar be employed, the colonies are never recognizable before the end of forty-eight hours, and show nothing strikingly characteristic before the fourth day. As the essential object of the examinations is to make an early and positive diagnosis, the saving of twenty-four hours would seem to be of vital importance in itself, but the serum method has also the advantage of permitting the diphtheria bacilli to bring their colonies to maturity before the other bacilli which are present have even commenced to form visible colonies. With agar, on the other hand, the two days needed for the appearance of the diphtheria colonies affords ample time for the development of the putrefactive forms, if these are present in any large number. The only advantage of the agar method is that the pyogenic staphylococci and streptococci which are usually present have more characteristic growth than on serum — a matter of secondary importance.

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* *Annales Pasteur*, July, 1890.

There is a current impression that the serum is difficult and troublesome to prepare, and this has led to the avoidance of its use in many laboratories when any other medium can be substituted. This idea is quite erroneous, as serum is as easily made as any of the other nutrient media — in fact, far easier than gelatine, if prepared according to the method given by Hueppe,* which consists in coagulating and sterilizing the serum at once simultaneously. After the tubes are filled to a depth of one or two inches, they are laid obliquely in rows in a thermostat, which is then heated till the inner temperature reaches 68° to 75° C. After half an hour or more at this temperature, the tubes will be found to have coagulated, leaving the serum nearly transparent. The temperature can now be raised to about 90° by bringing the water in the jacket to the boil, and the tubes should be exposed to this heat for half an hour each day on three or four successive days, when, on placing them in the incubator in the usual manner, all but a few will be found to remain perfectly sterile. If Lœffler's serum is required, the serum is mixed with one fourth its volume of Lœffler's bouillon before filling into the tubes. This addition does not interfere with the property of coagulating and remaining transparent. If blood serum is employed, care should be taken in collecting it that the clot is allowed to form before transporting the jars of blood. After standing forty-eight hours in a refrigerator or in a cool cellar, an abundant supply of clear serum can be obtained. The presence of small traces of hæmoglobin in the serum does not much impair its translucency, certainly not enough to render it unsuitable for the isolation of diphtheria bacilli.

The serum tubes could be prepared and kept in stock by druggists, if the method ever comes into general use, which seems unlikely. The examination may be made from material taken direct from the throat by scraping the membrane, or preferably, a piece of membrane may be detached by a pair of forceps or a swab of cotton wool. If the membrane has to be transported, it may be put into a clean, dry test-tube or folded up in blotting paper. To examine, it need only be moistened by a drop of sterilized water. A microscopical examination can be made by smearing the piece of membrane over the surface of a cover-glass, passing it three times through a flame. After drying and staining with a drop of any aniline stain, but preferably by Gram's method, the diphtheritic bacilli are seen as short, thick rods (about the same length as tubercle bacilli), lying in little groups. These bacilli are present in enormous numbers in the early stages of diphtheria, but diminish rapidly in number as the membrane softens. The highly characteristic involution forms, which assume comma or club shapes with swollen ends, and present a protoplasm broken up into small granules, are only recognizable with a good immersion lens.

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* *Centralbatt fur Bakteriologie*, July, 1887.

The cultures are made by drawing the infected needle in parallel lines along the surface of the serum. By treating two or three tubes in this fashion, the infecting material, at first abundant and producing a continuous dense growth, will in the second or third tube only implant a very few bacteria, so that the colonies can be studied separately. The tubes are to be kept at about body temperature for twenty-four hours, when minute white points appear on the surface of the serum, attaining about the size of pin-heads or of split peas. These, if found under the microscope to consist of bacilli, are probably the diphtheria bacilli, as the other forms would not have attained such size in so short a time.

The other colonies which attain such proportions in twenty-four hours are almost invariably found to be micrococci, usually the staphylococcus pyogenes.

I will not go further into the culture experiences with the bacillus than to say that I have been able, in all my cases, to confirm the statement first made by Welch and Abbott, of the Hygienic Institute, that the bacilli form an abundant invisible growth on potatoes, a medium stated by previous observers to be unsuitable for its cultivation. I also can substantiate the statement of Beck, that the agar cultures do not show the characteristic involution forms.

The method, however, has a serious defect, since an organism exists which is identical in size and appearance with the Lœffler bacillus, and grows on serum in a similar manner, though totally devoid of pathogenic properties. This is called the pseudo-diphtheria bacillus, and has been frequently found in the throats of healthy persons, as well as in follicular tonsilitis. The proof, therefore, is not absolute until substantiated by the inoculation of some susceptible animal. How far this pseudo-diphtheria bacillus would interfere with the method in practical work, is not yet certain. Personally I have so far only met with the virulent or true bacillus.

The results of my examinations are as follows: —

Of nine cases examined in which the diagnosis of diphtheria could be made without much difficulty from the symptoms and the appearance of the throat, the Klebs-Lœffler bacillus was found in eight. In the case where it was not found, the condition was one of an undoubted false membrane, which contained, microscopically, large numbers of bacilli which appeared to be the organisms in question, but did not appear in the cultures. When the specimen was taken, the throat had just been freely sprayed with a solution of hydrogen peroxide, and the negative result may have been due to its disinfectant power of inhibiting the growth, though the fact that colonies of staphylococci aurei appeared, makes that less likely. There was an anomalous course in this case, since the throat was found perfectly clear of membrane on the following day, preventing my repeating the experiment. In spite of this, the disease appears to have been true diphtheria, as the nurse stated that the patient had a distinctly nasal voice when he left the hospital, ten days later. The bacillus was also found in an anomalous case where an extensive false membrane existed with almost no disturbance of the general health. In this case there was no paralysis.

In six cases where the diagnosis was doubtful, the bacilli were not found. Several cases of follicular tonsilitis and a case of scarletinal sore throat were examined, with negative results.

I have divided the cases into two groups, — *a.* where the condition was clinically like diphtheria, and *b.* anomalous cases. The cases are as follows, the first being given in detail, and the remainder summarized in a table at the end of the article: —

Case 1.—M. L., female, aged 21, admitted April 9, 1891, into the female medical ward of the Montreal General Hospital, under Dr. Ross, with a suspicious-looking patch of membrane on both tonsils and a tiny membranous patch on the side of the uvula: temperature 102½°. Next day an extensive patch of dirty gray membrane was seen on the uvula and soft palate. Transferred to diphtheria ward. Seen on April 11; temperature 100°; had a patch of membrane on left anterior pillar of fauces. Discharged May 2; no paralysis.

Microscopic examination of the membrane showed an enormous number of short, thick bacilli, a few larger bacilli, and some clusters of micrococci.

Cultures in serum made on May 11 and kept at 35° C., showed on the following day numerous small, flat, white colonies composed of short, thick bacilli, having the typical appearance of the Lœffler bacilli. Involution forms numerous. In agar plates, small, flat colonies appeared on the second and third days, showing superficial, thin, concentric growth from a small central white spot. In stale culture in agar, the growth, on first transplantation, was barely visible, but in subsequent generations the colonies became more distinct, forming always flat, circular, concentric, white growths on surface about the entry point of the needle. Microscopically, the bacilli in the agar cultures were short, thick rods, with rounded ends; their length was about 0.0015 to 0.002 mm. (one and a half to two-thousandths of a millimeter). None of the agar cultures showed involution forms.

April 28, 1891.—Inoculated a very large, full-grown female guinea-pig with 0.7 c. cm. of a watery suspension obtained from washing a seven-days-old culture in six per cent. glycerine agar-agar. Injected subcutaneously in right flank.

May 6.—Found dead in cage; had been quiet and refused food for past three days. In right flank, at site of inoculation, induration and gray opacity of skin and subcutaneous tissue, with some hemorrhage; marked œdema extending from this spot to right axilla and backward to right groin.

Microscopically, a few bacilli corresponding in size to Lœffler bacilli, found in the œdematous fluid. Microscopic examination of blood, lungs, liver, kidneys, and spleen negative. Kidneys swollen, opaque, and grayish in sections; extensive swelling and degeneration of epithelium in convoluted tubes; a few casts seen in the tubules. From œdematous fluid cultures in two serum tubes showed on following day numerous small colonies of a bacillus corresponding to Lœffler bacillus with well marked involution forms, staining well by Gram's method. Cultures from blood, spleen, lungs, liver, and kidneys, all remained sterile.

The remaining cases, except a few of special interest, are briefly summarized in a table, as they were for the most part practically repetitions of the one given above. One case was of special interest, and occurred in the private practice of Dr. Major. In this case, which I saw for the last time on the seventh day, the membrane had nearly all gone, and on the first examination no Lœffler bacilli were found, although two agar tubes and two serum tubes, as well as three Petri dishes, were all seeded from a piece of membrane. In this case an oïdium appeared, strongly resembling that of thrush, and I considered the case to be thrush complicated with staphylococcus infection. Dr. Major stated, however, that at the onset the condition was unmistakably that of diphtheria, and the correctness of his diagnosis was proved some days later by the onset of severe and persistent paralysis of the palate. In the interval I had obtained a fresh piece of membrane, which yielded two colonies of the Lœffler bacillus. This case shows that a negative result is of no diagnostic value when the membrane is clearing, even when a fairly exhaustive examination has apparently been made. In another case I found an oïdium growth, readily distinguishable, however, from thrush, associated with a large number of Lœffler bacilli.

The uncertainty of examinations made at a late period in cases going on to recovery, was shown in another case, for the opportunity of examining which I am indebted to Dr. W. S. England. In this case I saw the patient on the seventh day. A distinctly membranous exudation had been present, returning within twenty-four hours after being scraped off, but always confined to the tonsils. In this case, smear cultures on five glycerine agar tubes failed to show any bacilli, the seeding being done directly from the membrane in the throat. In this case a tiny particle of membrane which had been obtained at the time of examination, was seeded on serum a week later, and yielded two colonies corresponding to the Lœffler bacilli, one of which was tested and found to kill a guinea-pig in the typical manner.

In two cases I had great difficulty in obtaining suitable material for examination, owing to the affection's being confined to the posterior nares, and where a prolonged local examination seemed unjustifiable, owing to the profound exhaustion of the patient. In these cases I made cultures daily from the nasal discharge for several days, but without in any case obtaining the Lœffler colonies. In one of these cases (Case A 2) the nurse afterward obtained for me a small fragment of membrane, from which I obtained colonies having the characteristic culture appearances, and which killed a guinea-pig in the typical manner. In the other case (Case B 2), staphylococci aurei and citrei were present in enormous number, together with a few streptococci, but no Lœffler bacilli were found.

In a fatal case (Case A 9), where an autopsy was performed by Dr. Finley, who kindly sent me the respiratory organs for examination, the larynx and trachea showed an extensive sheathing of diphtheritic membrane extending down to the main bronchi. Large numbers of the Lœffler bacilli were obtained from this membrane, and an area of pneumonia from the lung showed a small number of the bacilli associated with a large number of small diplococci. No streptococci were found.

In an anomalous case already cited, brought to my notice by Dr. H. S. Birkett (Case B 5), an extensive soft, yellowish membrane covered the posterior nares, and extended over the epiglottis and into the larynx. The membrane could be readily removed without causing bleeding, but tended to recur. The general health of the child was unaffected. Cultures on agar yielded an abundant growth of a single bacillus form, forming prominent yellow-white surface colonies. Inoculated into the conjunctiva of rabbits, no effect was produced, and I was inclined at the time to regard the bacteria as being possibly the pseudo-bacillus; but on re-investigating the cultures some three months later, I found that they gave the typical Lœffler colonies on serum, with an abundant invisible growth on potatoes, and showed on both these media most characteristic involution forms. Inoculated into a guinea-pig, this organism showed a high degree of toxic virulence, killing the animal in thirty-six hours. The autopsy on this animal showed an opaque hæmorrhagic, reddish-gray indurater area at the spot of inoculation, surrounded by a zone of serous œdema. Cultures from the organs, and from the serous exudation, remained sterile, but typical Lœffler colonies were obtained from the circumscribed hæmorrhagic patch at the site of inoculation. These colonies, on being transplanted on agar, gave only the characteristic, flat, compact, concentric surface growth of the Lœffler organism, and not the abundant, prominent growth of the original tubes. For this reason it appears probable that the original colonies were impure, containing both the Lœffler colonies and some other form, which latter was subsequently eliminated in passing through the serum culture.

In cases which were examined at an early stage, the Lœffler bacilli were found almost in pure culture. In most cases the staphylococcus aureus was found, but it was usually scanty. The colonies closely resemble those of the Lœffler bacilli for the first day, but can be distinguished at the end of forty-eight hours. Streptococci were seldom met with, and then only in isolated colonies, the scarcity of this organism being contrary to what I had been led to expect from a study of the literature. In the anomalous or doubtful cases, on the other hand, either staphylococcus and streptococcus, or both together, were present abundantly in all instances. The influence of these pyogenic bacteria on the course of true diphtheria is a point greatly needing investigation.

In cases examined during the period when the membrane had begun to soften,— that is to say, after the third day in ordinary mild cases,— the falling off in the number of diphtheria bacilli was most marked. This did not seem to be due here to the antagonistic action of saprophytic bacteria, as has been commonly assumed, since, as a rule, the cultures made in late stages in cases going on to recovery remained perfectly sterile, except for the few scattered colonies of Lœffler bacilli. This result I attribute to the inhibitory action of the local disinfectant applications,— in most of the cases a spray of peroxide of hydrogen wa employed,— but I have made no experiments to determine this point.

A matter of considerable interest is the question whether this method of examination will ever come into general use, and if such be the case, what class of practitioners could carry it out to the best advantage. This point is considered by Prof. Welch, of Baltimore, in an address delivered before the ninety-third annual session of the Medical and Chirurgical State Faculty of Maryland, in April, 1891.* In this address, which by a masterly treatment of the facts places the prophylaxis and treatment of diphtheria on a broad scientific basis, Professor Wlceh does not think that the hopes of Roux and Yersin,— that the method may yield good results in the hands of unskilled persons,— are likely to be realized. He thinks that an elementary training in bacteriology is needed in those carrying it out, and suggests that as elementary courses on bacteriology have now become so common, it will not be long before most communities will possess at least one person capable of doing the work satisfactorily. My own experience has shown me that doubtful cases, which are those in which the value of the method should be best shown,— the chief difficulty is in obtaining suitable material for examination,— are of two kinds: first, those where the condition resembles tonsilitis, and the exudation is confined to the tonsils; and, second, those where the local disease is situated in some part of the respiratory tract not readily examined, or where the severity of the constitutional symptoms renders a prolonged examination difficult. As the procuring of a small piece of the false membrane at the earliest period possible is the *sine qua non*, and to do that in this latter class of cases requires a special manipulative skill only possessed by a skilled laryngologist, the task will properly fall to this individual. The aid of a throat specialist seems indispensable in cases where the local examination presents much difficulty. Possessed of suitable material, the best results in the further examination would certainly be obtained in a properly equipped laboratory.

In the cases where the confusion arises from the membrane's being confined to the tonsils, the case is much more simple, and there is less need of the services of the laryngologist, all that is required being to detach a small piece of the exudation, wrap it in paper, and send it to some laboratory for examination.

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* *Medical News*, May 16, 1891.

Considering the gravity of the interests at stake in the prompt recognition and isolation of cases of diphtheria, one would naturally suppose that a method which enabled a positive diagnosis to be made within twenty-four hours, in cases seen during the first days of the illness, would be welcomed eagerly by the profession. That this has not happened is due probably in great part to the wise precaution of treating all doubtful cases as if they were cases of diphtheria, and possibly, too, in some degree to a tendency to pride ourselves upon our sagacity, valuing the result of a clever guess more than that obtained by a less brilliant, though more certain, method. As a matter of experience, a large proportion of the doubtful cases, especially the tonsilitis group, declare themselves to be one thing or the other by the time the doctor makes his visit on the following day.

In conclusion, it may be stated:—

1. That in almost all cases where strong clinical grounds exist for the diagnosis of diphtheria, the bacteriological examination has shown the almost invariable presence of the malignant Lœffler bacilli.

2. That, excepting in connection with scarletina, measles, or erysipelas, the number of cases of diphtheritic sore throat due to other causes is very small.

3. That in doubtful cases the accuracy of the method depends chiefly upon obtaining suitable material at an early stage of the disease.

4. That the method is not of much service in doubtful cases where the difficulty is due to the infection occurring in localities difficult to examine without skilled manipulation, unless suitable material is obtained for examination.

SUMMARY OF METHOD FOR DETECTING LŒFFLER BACILLI.

Microscopical Examination.—Stain a cover-glass smeared by a bit of membrane with any aniline dye. The bacilli are arranged in small clumps, and are short, thick rods, about same length as tubercle bacilli, but much thicker; numerous beaded and drumstick shapes met with—in solution forms. Gram's staining method can be employed.

Cultures can be made direct from membrane in throat or from small bit of membrane folded dry in clean paper. No special antiseptic precautions necessary. Touch or scrape membrane with a sterilized platinum needle, and draw it in parallel streaks over the surface of a serum tube, using two or more successive tubes before reinfecting the needle. Keep the tubes at body temperature. In 20 to 24 hours the Lœffler bacilli appear as small grayish-white points, size of pin-heads, showing under the microscope the characteristic appearances of the bacilli in the original membrane.

Diagnosis.—(*a*) Other bacilli do not form visible colonies at twenty-four hours. (*b*) Staphylococcus colonies resemble those of Lœffler bacilli to naked eye appearance, but recognized on microscopic examination. (*c*) Pseudo-diphtheritic bacilli have microscopic and culture characters of the Lœffler bacilli, but have no pathogenic properties.

Pathogenesis.—Subcutaneous inoculation of guinea-pig kills in two to five days, with hæmorrhagic necrosis and œdema at site of inoculation. The bacilli can be recognized microscopically and by culture near spot of inoculation, but blood and viscera give negative results. Disseminated parenchymatous degeneration of liver and kidneys.

The following is a tabular analysis of the cases, divided into two groups: —

GROUP A.— CASES EVIDENTLY DIPHTHERIA.

Number of cases examined, 9. Result: Positive, 8; Negative, 1.

No.	Name.	Sex.	Age	Service.	Course.	Result of Examination.	Remarks.
1	M. L.	F	21	M. G. Hospital.	Recovery.	Typical.* Oïdium also found.	Began as Tonsilitis.
2	L. E.	M	2	"	Death.	Typical.	Nasal diphtheriaf Bacilli in bit o. membrane. None in nasal secretions.
3	Mrs. T.	F	28	Dr. England.	Recovery.	Two colonies only.	
4	W. P.	M	16	M. G. Hospital.	"	No Lœffler bacilli; abundant staphylococcus pyogenes aureus.	Rapid disappearance of membrane, (nasal voice.)
5	L. M.	F	10	Dr. Major.	"	Only two colonies found. Oïdium present.	Marked diphtherial paralysis.
6	F. P.	M	8	M. G. Hospital.	"	Typical.	
7	E. G.	F	10	"	"	Typical.	
8	L. P.	M	13	"	"	Typical.	
9	M. G.	F	4	"	Death.	Typical.	

*In cases marked "Typical" a large number of the virulent Lœffler bacilli were found.

GROUP B. — ANOMALOUS CASES.*

Number of cases, 5. Result: Positive, 1; Negative, 4.

1	O. P.	F	20	M. G. Hospital.	Recovery	Negative.	Exudate confined to tonsils.
2	C. W.	F	24	"	"	Negative.	Nasal diphtheria? Nasal voice. Local examination unsatisfactory.
3	A. C.	M	1	"	"	Negative.	Local examination unsatisfactory.
4	W. J.	M	8	"	"	Negative.	Scarletina.
5	S.	M	8	Dr. Birkett.	"	Positive.	

*Cases 1, 2, 3 of this series were placed in the diphtheria ward of the Montreal General Hospital. Several cases of follicular tonsilitis were also examined, always with negative results.

CYTOLOGY OR CELLULAR BIOLOGY.

REV. A. M. KIRSH, C. S. C.

CELLS ARE INDIVIDUALITIES — THEY ARE STRUCTURED AND LIVING.

At present, all well-informed men know that the body of organized beings such as plants and animals consists of small parts which, within certain limits, resemble one another. These ultimate components have been called cells, a name, strictly speaking, not in harmony with the present state of knowledge: nevertheless it is retained in science, and in fact it would be difficult to replace it, owing to its universal use. Professor Sachs, in his "Physiology of Plants," Lecture VI., declares that "the true meaning of the word *cell* may be quite clear to but few, the less so since biologists themselves even now hold and discuss the most different opinions upon it."

According to Canon Carnoy, "Cells are elementary organisms or individualities of organized beings." This view is now very commonly accepted, and, indeed, cells are now commonly regarded as independent living beings, which sometimes exist by themselves alone, and sometimes are joined with others, millions of them, to constitute a cell-colony, or, as Hæckel calls it for plants, "a cell republic." In fact, according to this view the cells constitute the individual somewhat as the zoöids constitute the individual Hydrozoan, or the polypi constitute that of the Actinozoan.

Many however, with Sachs, consider cells as only one of the products of the formative forces so universally found in matter, and particularly so in organic substances. In the inorganic substance the highest expression of formative force is the crystal; but not all matter attains to that state, although all inorganic matter tends to it, and certainly would reach it if the proper conditions were always and everywhere realized. In the organic world we find the cell as the highest realization of formative force; whether this form is always realized is another question, but it remains nevertheless true that the cell is the organic unit, just as the molecular crystal is the unit of composition in the inorganic world. We are therefore justified in a certain measure in considering cells as elementary organisms or individualities of organized beings. S. Howard Vines expresses this view in the following words: "The body of a plant, like that of an animal, consists of one or more structural units, which are termed cells, and in plants, as in animals, the cell consists essentially of an individualized mass of protoplasm." M. Foster considers cells as only anatomical units, but rejects them as physiological units. Schwann and Schleiden, he says, "considered the properties of the cell, as they described it, as the mechanical outcome of its build," and further on he says, "With this anatomical change of front the physiological cell-theory was utterly destroyed. The cell was no longer a unit of organization, it was merely a limited mass of protoplasm, in which, beyond the presence of a nucleus, there was no visible distinction of parts." To maintain his position, this author selects the amœba as an example, in order to show that cells are not structured; and whether his arguments are conclusive we leave the reader to judge from his own words. "In its simplest form a living being, as illustrated by some of the forms often spoken of as amœbæ, consists of a mass of substance in which there is no obvious distinction of parts. In the body of such a creature even the highest available powers of the microscope reveal nothing more than a fairly uniform net-work of material, . . . the intervals of the meshwork being filled, now with a fluid, now with a more solid substance, or with a finer and more delicate net-work, and minute particles, or granules, of variable size. . . . Analysis with various staining and other re-agents leads to the conclusion that the substance of the net-work is of a different character from the substance filling up the meshes. Similar analysis shows that at times the bars or films of the net-work are not homogeneous, but composed of different kinds of stuffs." From this the reader sees that the author contradicts himself. If there is no visible distinction of parts, as he at first declares, why does he then call attention to the differences in composition, and even to the different parts composing the cell of the amœba? Precisely because he cannot get over the idea that the cell is made of different stuffs, as he calls it, and that there are parts in it which not only differ in composition but in appearance; in a word, the cell is not a homogeneous substance, but is composed of parts; in other words, it possesses structure. But in bringing together what is known of the cell, it is not my purpose to enter into controversy; I therefore leave the reader free to hold his own opinions.

I will state the thesis of Carnoy in his own words, and follow him as closely as possible in its exposition and demonstration. Prof. Carnoy maintains that, "Cells are elementary organisms or individualities of organized beings," and that the cell is " a structured and living mass of protoplasm surrounded by a membrane and containing a nucleus."

THE CELL IS AN INDIVIDUALITY.

By this is meant that every cell is autonomous, that is, it constitutes a whole capable of acting by itself, and for itself; it is endowed with an individuality proper to itself. This is not only true for unicellular beings, but also for the cells composing higher beings, provided, however, that the cells possess the necessary conditions to display their activity, which often requires the concurrence of other cells of tissues, and even of the whole being.

Closely related to this question is that of cell-fusion. For my purpose, however, it is sufficient to state that by the fusion of cells the individuality may be lost, but that this is not a necessary consequence. Thus, for example, in fertilization, the male cell and the female cell fuse so perfectly together, protoplasm with protoplasm and nucleus with nucleus, that the individuality of each cell is lost, and the result is a new individual, the so-called cell of segmentation.

In forming a plasmodium, cells that have been free sometimes fuse in great numbers, but this fusion is not so perfect as in the case of the union of the germ cell with the sperm cell; for here protoplasm fuses with protoplasm and nucleus with nucleus, but in the case of a plasmodium the nuclei remain distinct, and the cell has the appearance of being an ordinary multinucleated cell; in this case also, the individuality of each cell has been lost. Examples of the same kind are presented by the Myxomycetes, lactiferous tissue, and particularly in the sporangia of many plants. In many other cases, however, the fusion between cells is only at the points where they touch each other, and the cells then do not lose their individuality; they still act for themselves. Cases of this kind are rather common; for example, muscle cells fuse with cells of glands, and nerve cells with cells of muscles.

Fromann believes that he has been able to trace a connection of the protoplasm through the walls of adjacent cells, and hence some biologists believe in the continuity of protoplasm. If such be the case in any plant, then such a plant may be considered as a variety of plasmodium. Another difficulty we meet in the Cœloblastæ, especially in the genera Caulerpa, Botrydium, and Vaucheria. Here we find large and sometimes branching filaments without partition walls. Sachs considers them as simple cells which may be multinucleated, while others consider them as cellular filaments in which the partition cell-walls have never been developed. They may be considered as plasmodia from the beginning, or plasmodia by direct formation.

But enough has been said to make the meaning clear. The individualization of protoplasm in the form of a cell is the aim of formative force in the organic world; but whether this typical representation of the life unit is always and in every case realized, is a different question. An old adage says, "No rule without exceptions," and this seems to be especially the case in organic nature.

In the second part of the thesis it is stated that a cell is "a structured mass of protoplasm." Here I call the reader's attention to what has been said in the beginning of this paper. Many authorities could be cited for and against this view, and, for that matter, authorities differ upon almost every important point in science, so that there is at least an apparent reason for the oft-expressed opinion that seldom two biologists agree on the same point; but then we have the consolation that we are not the only class of people to merit this reproach, for it may be applied with equal justice to the philosophers, and I believe these have the honor of priority.

When I say that the cell is a structured mass of protoplasm, etc., I mean that it is endowed with organization, *i. e.*, composed of different parts which are united together in a determined manner, and have different relations with each other. An observer must be blind, or his microscope is of the most primitive pattern, if it does not show him that cells are more than a homogeneous, amorphous, or crystalline mass, similar to inorganic substance. My tube at least shows me in a cell separate elements, arranged according to a well-defined pattern. On the outside I notice a membrane, which is more or less distinct, closed, and possessing a certain resistance. Inside of this may be noticed a viscous and apparently hyaline and homogeneous mass, but studded with numerous granules (microsomata); within this substance a peculiar body, the nucleus, which is also limited by a membrane, and within which is also found a hyaline substance, and in this substance are noticed curiously shaped bodies, variable in size for different nuclei.

Thus is sketched in a few words the gross anatomy of the cell. But this is only superficial and as it were a macroscopic aspect of the cell structure. Arming the eye with the best of lenses, and examining attentively every part named, we discover details in the structure which are truly wonderful. Good and typical cells, which Leydig already used for observation, may be found in the epithelial lining of the intestines of the little crustacean *oniscus murarius* (pill-bug or wood-louse). This animal is quite common, gathering sometimes in great numbers under boards placed along the foot of a wall.

By magnifying these cells only about 260 diameters, and properly staining them, the protoplasm is seen to be hyaline and transparent, but is far from being homogeneous. In fact, fine threads may be seen radiating from the nucleus toward the cell-wall; these threads send out lateral branches, which unite with others so as to constitute a real net-work, which is technically called the reticulum. The meshes formed by these interlacing filaments are of various sizes, and are filled with a hyaline, minutely granulated substance, which Professor Carnoy first (1883) designated by the name of enchylema.

Between the cells may be seen a shining zone, divided in the middle by a dark line, the primitive membrane, common to juxtaposed cells, as it is the result of cell-division, and at first constitutes only a simple partition between the cells; but subsequently each cell constructs a wall for itself, and this secondary membrane is the white shining lamella seen between the cells.

Next, by focusing upon the membrane of the cell, we may see two things; very minute points, caused, no doubt, by the threads in the membrane crossing each other. These belong to the primitive membrane, and the meshes they form are very minute and hardly visible, but in the secondary membrane the meshes are large and the threads clearly visible. We are therefore led to the conclusion that the membrane also possesses a reticulum and an enchylema, and is structured.

Finally within the protoplastic mass may be seen the nucleus, shining like a beautiful pearl. In it may be seen trabeculæ crossing each other, constituting apparently a delicate net-work. But this is a deception, for if accidentally the needle used in dissection has drawn out a nucleus, we at once see that this is not a real net-work, but that this filament is really a continuous thread, and that it produced the appearance of a net-work, owing to its convolutions which cross and recross, the result being that the nucleus has the appearance of containing a beaded net-work.

Methyl green will stain the filament alone; ammonia and hydrochloric acid will make it disappear, and so reveal the membrane of the nucleus, the nucleoli, the real reticulum of the nucleoplasm with its meshes filled with the nuclear enchylema. Wonderful indeed! Can then the nucleus possess besides this long continuous thread also its own proper reticulum and enchylema ? — It seems so.

In the following communications I shall describe the structures more minutely ; it is here sufficient for my purpose to have arrived at the conclusion that in the epithelial cells of the *oniscus murarius*, the three constituting parts of the cell, the membrane, the protoplasm, and the nucleus, possess each a similar structure consisting of a reticulum, the meshes of which are filled with a granular substance or enchylema.

Leydig, as before stated, had already observed these cells, but he believed that this structure was peculiar to them alone, but Carnoy proves that this is not an exceptional case; on the contrary he affirms that this is common to all cells, at least he has found many similarly constructed cells in both kingdoms of nature.

This structure is especially to be seen during the period of activity of the cell, and particularly during the process of cell-division, also during the formation of spermatozoids in the spermatoblast, etc.

But this is not all. Nægeli maintains that the organic bodies, and consequently the cell also, have their own molecular constitution. It would require too much space to develop this subject here, but I would refer the reader to "Sach's Text-book of Botany" for an exposition of Nægeli's theory. In the last part of the thesis it is stated also that "the cell is a living mass."

By this we mean to say that in the cell, phenomena take place which are peculiar to organic bodies, and which are grouped under the comprehensive name of "life." These phenomena, although many and various, may be grouped under two headings; viz., simple physical movements, and chemical movements, their object being the nutrition, the growth, and the reproduction, or multiplication, of the cell.

In subsequent papers, I shall treat this question more fully, but here I wish to state that the protoplasm is not alone concerned in this activity, but that the membrane and nucleus also participate in the life activity of the cell. The entire cell is therefore living. To it we must ultimately descend to sieze life in its source, and here we may study the phenomena of life in their simplest expression.

If it is ever allotted to mortal man here below to arrive at any knowledge of life, it is clear that a complete and profound knowledge of cytology will be the key to the mysteries of that now unknown region.—*The Microscope.*

LESSONS IN BACTERIOLOGY.

BY PAUL PAQUIN, M. D., D. V. S.

LESSON VII.—CULTIVATION OF BACTERIA.

PART I.—INOCULATIONS OF CULTURES.

THE greatest difficulty in the way of bacteria culture, is that minute organisms are everywhere present, and that bacteria are so exceedingly small that it is impossible to plant only one or two, as in larger vegetables. They are usually mingled, and cannot be dissociated and separated at will by mere mechanical manipulations and dexterity at the moment of gathering, or any other time. So it is often unavoidable to plant a variety of germs in the same grounds when attempts are made to reproduce any one of them and propagate the species. As many will grow equally well on or in a given food media, it follows that the crop will be a mixture of forms, among which the particular properties of each cannot be realized. The cultivation of mingled germs, then, is of no value, except in particular cases when one desires to see their combined effects, etc. In all cases it is necessary to separate the forms from one another, isolate them, and cultivate them in a state of purity.

There are several methods of accomplishing this, but two of them are sufficient for all practical purposes. They consist of the "physiological differentiation" and the "colony differentiation."

The first is a method by which material containing various bacteria is inoculated into animals, such as rabbits, guinea-pigs, cats, dogs, mice, rats, pigeons, etc., in which only the virulent forms capable of growing in the susceptible individuals, develop locally or generalize through the circulation, while the others die. This process is good only to reveal and isolate pathogenic microbes in susceptible animals, and would not be sufficient in case one wished the isolation of each and every kind, pathogenic or not. When it is desired to isolate microbes from a specimen of virulent material, such as septic blood, pus, etc., this may suffice, or may at least be of much utility.

It must not be forgotten, however, that a number of germs may grow simultaneously in the same animal, and even in the very same spot. In tuberculosis, for instance, we often find ordinary pus microbes, and a form known as micrococcus tetragenus vegetating in the same place. This association is frequently noticed, on the other hand, in artificial cultures in test tubes, etc.

The second method is an artificial isolation of the forms mingled, by planting them very thinly over a wide, smooth surface, thereby allowing each germ, or a few of them, to develop apart, here, there, everywhere, and start a special colony. The nutritive surface consists usually of meat broth and agar-agar, or gelatin poured warm on a piece of glass, say 3 x 4, and allowed to cool down and solidify. Or the medium may be in a thin layer in the bottom of a conical flask, making a uniform surface accessible with a platinum needle.

To prepare the plate cultures, sterilize some pieces of glass 3 x 4 to 4 x 6 (as are used for sterilized mashed potato, see page 463, July number), wrapped in cotton cloth, or inclosed in a tin box for the purpose. Put one of these carefully and quickly on a little glass bench contrived into the bottom of a flat glass dish, as is used for potato culture,* and cover quickly with another glass dish fitting over, and used as a lid. A small quantity of sterilized solid nutritive media is then melted in a test tube, and emptied carefully in the center of the plate with the right hand, while lifting the lid slightly with the left. The media may be deposited with a sterilized pipette, instead of directly with a test tube. It will then spread in every direction from the center, providing the surface is not too cold, and is perfectly level. In well equipped laboratories, the dishes are placed on tripods, by which the plane may be regulated at will by a mechanical device. This is very convenient, but not indispensable. To obtain isolated colonies of bacteria on such a surface, one needs only to spread very sparsely the material containing them. Thus, if a fluid is to be analyzed, a platinum needle sterilized by passing it in a blaze until white, is plunged into it, and streaks are made with it about half an inch apart across the plate. It is usually necessary to sterilize the needle repeatedly, and dip it as often into the material to be inoculated, for each streak desired in the nutritive surface. For this operation, the lid of the culture dish need only be lifted one side enough to introduce the needle.

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* A cut of such a dish will appear in the November number.

If it is desired to obtain the bacteria from a solid material, it may be dried, if this is practicable, without too high heat (less than 200° F.), pulverized very fine, and a little of the powder may be spread over the culture surface. If it is a solid substance that cannot be pulverized, it may be put in a little sterilized distilled water, in a large sterile test tube or small flask, shaken thoroughly, and allowed to soak awhile; then inoculate from the liquid. Sometimes it is found necessary to mash the material from which cultures are desired, in sterilized water, in a sterilized mortar and pestle, to obtain the best results.

PART II.—GATHERING SPECIMENS.

Special precaution is necessary in gathering most specimens for bacteriological studies, in order to exclude air germs from them as much as possible. If practicable, the material ought to be gathered without contact with these. It is not always easy to do this, even when it is practicable, however, and occasionally circumstances are such as to make ordinary, well-known methods unavailable. In such cases, one must draw on his own inventive resources, always bearing in mind that absolute purity from external contamination is a requisite.

In gathering fluid collected in a sack or any cavity, such as arteries, veins, the heart, abscesses, connective tissue, etc., one may use either a sterilized hypodermic syringe, or a sterilized glass pipette, and aspirate the fluid with the mouth at the other end; or, if it be one with a vacuum, it will suck in of itself when the point is broken in the interior of the collection.

In live tissue the hypodermic syringe is preferable. To prepare it, wrap it, ready to use, in cotton cloth or clean cotton wool, or inclose it in a special metal box that may be contrived for the purpose, and sterilize it at a moist temperature.

Wash the surface of the skin thoroughly with boiled water, and wet it with bichloride of mercury, 1–2000. Then take the syringe by the barrel and piston head without touching the needle with the fingers, or exposing it to contamination with any object. Thrust the point carefully into the spot to be aspirated, as in hypodermatic injection, tear the meshes of the tissues, if any, by a movement of the needle in a horizontal plane, and draw out the material slowly and steadily. Withdraw the syringe carefully and quickly, inclose it again in the sterilized envelope (cotton, etc.) that contained it before its use. Once in the laboratory, the contents may be used for cultures, and mounting as per processes to be treated later (in these pages). In a few words, the disposition of the matter consists in dropping, with greatest care, a drop of material on the nutritive media, being particular that the first one or two drops that are at the end of the needle fall outside, as they may possibly be contaminated with air-germs. With a syringe having a stop cock at the junction of the needle and the barrel, it is less dangerous to have any contamination of the substance within, and it may be handled more easily and more safely.

In dead tissue, such as the cadaver of an animal or a man, the syringe may again be used, but usually advantage is taken of such occasions to gather material to keep. If an animal has died from anthrax, for instance, pure bacilli may be obtained in aspirating blood from the ventricles, and preserved almost indefinitely, perhaps. For such cases, sterilized glass pipettes are used.*

The surface is seared with a red-hot glass rod or platinum instrument to destroy the microbes adhering to it, and the pipette is carefully thrust into the cavity. If a pipette with vacuum is used, the pointed extremity to be inserted is passed two or three times in the blaze of an alcohol lamp or gas jet, to burn the organisms on it, then it is pushed carefully by a rotary motion into the tissues covering the material; the point is broken inside by pressure, and the vacuum will fill with fluid. Care should be taken that the suction completely stops without interference before withdrawing the pipette, because it may suck air the moment the point is out, and then the gathered specimen is useless. To avoid this, be sure to pull the pipette back and forth two or three times without withdrawing it, and grate the point on the tissues within, in order to break it shorter still, and dislodge any obstruction that may be in it. This is indicated, as a rule, when suction ceases before the pipette is more than half full. When reasonably sure that suction is ended, withdraw the tube, and seal the point quickly in a blaze.

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*Cuts and description of these will appear in next issue.

If a pipette with only one point, the other being plugged with cotton, is used,— one in the shape of a sharpened lead pencil for instance,— the point may be broken before using, sterilized in a blaze as for the vacuum kind, and inserted in the same way through the seared surface. Then draw in the fluid by aspirating with the mouth, and seal the point on withdrawing it. Seal likewise the other extremity, either on the spot or at the laboratory. If the fluid is gathered away from the laboratory, it is necessary to seal both extremities at once, in order to carry it, otherwise one must carry it point downward, the mouth (upper end) being protected by the plug of cotton through which germs cannot penetrate, but which would allow the oozing of the fluid within, if turned downward. One cannot seal the mouth end with an ordinary alcohol lamp blaze, so it is necessary to make, in advance, a neck on the aspirating tube about a half inch from the mouth below the plug of cotton, so as to have a comparatively thin diameter of glass to melt and seal after filling.

Sometimes it is desired to get microbes from solid tissues without exposing them to putrefactive germs. For instance, in a case of death by septic disease, one may wish to get and carry away the microbes in lymphatic glands, or the liver or spleen or muscular tissue, and it may be impossible to gather them in the field. In such cases, the organs, if not too large, such as the kidneys, spleen, etc., may be carefully removed, and immersed at once in pure glycerine. This will arrest the germs outside, and in the outer layer of tissues, but will leave the center microbes alive for days, weeks, and even months, in large specimens. The same thing may be done with portions of solid tissue. I am not aware that I ever saw this method recommended, but I had occasion to recur to it in a case of emergency, in which invention was necessary, and I obtained good results from it. It should be resorted to early after death.

These are the most important points in the gathering of specimens. It is needless to say that many substances cannot be gathered free from air germs, but still the greatest care ought to be taken to exclude all foreign bacteria possible after collecting. It is, for instance, usually impossible to get discharges from the lungs, nose, and mouth, free from forms floating in the air; and it is rare that any special bacteria can be found alone in the bowel evacuations. Differentiating methods must usually be resorted to in these cases, *i. e.*, plate cultures, etc.

(Eighth lesson in November number.)

SELECTIONS.

PREVENTION OF SMALLPOX.

EXTRACT FROM A DOCUMENT ISSUED BY THE MICHIGAN STATE BOARD OF HEALTH.

1. *Smallpox a Preventable Disease.*— It has long been known that smallpox can be prevented or modified by vaccination. It is now believed that a wide-spread epidemic of the disease can be attributed only to an equally wide-spread ignorance or willfulness concerning smallpox and its prevention by vaccination.

2. *Why Vaccinate.*— Because unmodified smallpox is so deadly a disease, and so often disfigures and enfeebles those who recover;* and because by traveling or by travelers, by articles received in the mail or from stores or shops, or in various other ways, any one at any time may without knowing it be exposed to smallpox, it becomes important, so far as possible without injury to health, to render every person incapable of taking the disease. This may be done so perfectly by vaccination and revaccination with genuine bovine vaccine virus, that no question of ordinary expense or trouble should be allowed for a day to prevent the careful vaccination of every man, woman, and child in Michigan, and the revaccination of every one who has not been vaccinated within five years. It is well established that those who have been properly vaccinated are far less likely to take smallpox if exposed to it, and that the very few who have

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* "Among those who outlive it, many either totally or partially lose their sight or hearing; many are left consumptive, weakly, sickly, or maimed; many are disfigured for life by horrid scars, and become shocking objects to those who approach them. Immense numbers lose their eyesight by it."— *La Condamine.*

been properly vaccinated and have smallpox, have it in a much milder form, and are much less disfigured by it than those who have not been thus vaccinated. The value of vaccination is illustrated by the following facts: —

On March 13, 1859, Dr. E. M. Snow, of Providence, R. I., found, in a cluster of seven houses, twenty-five families, and in these families ten cases of smallpox, all apparently at about the same stage of the disease. In the same families there were twenty-one children who had never been vaccinated. The ten cases and the remaining members of the families, including the twenty-one children, were quarantined at home; and the children were all vaccinated, and compelled to remain with the sick. Several other cases of smallpox occurred in persons previously exposed, but not one of the twenty-one children referred to had the slightest touch of the disease.

In Sweden the average number of deaths in each year from smallpox per one million inhabitants was,—

Before the introduction of vaccination (1774–1801), 1,973.

During the period of optional vaccination (1802–1816), 479.

And during the period of obligatory vaccination (1817–1877), 189.

Vaccination was introduced in England near the beginning of the present century, and since 1853 compulsory vaccination has been attempted. In England the number of deaths in each year from smallpox per one million inhabitants was,—

At the close of the last century, 3,000.

From 1841 to 1853 (average), 304.

From 1854 to 1863 (average), 171.

In the Bavarian army revaccination has been compulsory since 1843. From that date till 1857, not even a single case of unmodified smallpox occurred, nor a single death from smallpox.

During forty-two years of duty, Dr. Marson, physician of the London smallpox hospital, has never observed a single case of smallpox in the officers and employees of the hospital, who are revaccinated when they enter the service, and who are constantly exposed to the infection.

"Out of more than 10,000 children vaccinated at Brussels with animal lymph, from 1865 to 1870, and who went through the terrible epidemic of smallpox, which in 1870 and 1871 frightened the world, not a single one was, to my knowledge, reported as being attacked by the disease. The same immunity was shared by those — a much larger number — whom I had revaccinated, and who at the same time were living in epidemic centers."*

3. Who Should be Vaccinated.— Everybody, old and young, for his own interest and that he may not become a breeding-place for the distribution of smallpox to others, should seek that protection from smallpox which is afforded by vaccination alone. It is believed that all persons except those mentioned in the following paragraph may, if the operation is properly performed, at the proper time, and with pure bovine virus, be vaccinated with perfect safety to themselves. Even those who have had smallpox should be vaccinated, for otherwise they may take the disease; and it seems to be proved that a larger proportion of those who have smallpox a second time die, than of those who have the disease after vaccination.

4. Who Should not be Vaccinated. — Unless exposure to smallpox is believed to have taken place, or likely to take place, teething children, pregnant women, persons suffering with measles, scarlet fever, erysipelas, or susceptible to and recently exposed to one of these diseases, persons suffering with skin disease or eruption, and in general, feeble persons not in good health, should not be vaccinated. In all cases in which there is any doubt as to the propriety of vaccinating or postponing vaccination, the judgment of a good physician should be taken. The restriction as to vaccinating teething children makes it important that children should be vaccinated before the teething process has begun, because smallpox is very much more dangerous than vaccination. Smallpox is exceedingly dangerous to pregnant women.

5. When Should a Person be Vaccinated? — The sooner the better, as a rule, and especially whenever there is much liability of exposure to smallpox. Children should be vaccinated before they are four months old; those who have never been vaccinated, should, with the exceptions previously made in paragraph four, be vaccinated at once. Because the vaccination often loses its protective power after a time, those who have been vaccinated but once or twice should, in order to test and to increase the protective power of the former vaccination, be vaccinated again, as often as the vaccination can be made to work. For the first three or four scars the protection afforded is believed to be somewhat in proportion to the number of good scars, conditioned always that the scars be the result of a proper vaccination with genuine vaccine virus. In general, to insure full protection from smallpox, one should be vaccinated as often as every five years. It has been found that of those who have smallpox, the proportion of deaths is very much less among those who have three or four good vaccination scars than among those who have but one scar.

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* Dr. Warlemont, of Brussels, *North Carolina Medical Journal*, January, 1880. Vol. V., p. 2.

Vaccination as late as the second day after known exposure to smallpox is believed to have prevented the smallpox; vaccination the third day after exposure has rendered the disease much milder than usual, and, in a case in Iowa, vaccination on the seventh or eighth day after exposure to smallpox, ran a partial course, and was believed to have modified the attack of smallpox, which, however, it did not wholly prevent.

6. *With What Should One be Vaccinated?* — Virus taken from the arm of one vaccinated a second time, is worthless because unreliable. Virus dissolved and carried about between glass slips in the pocket of the vaccinator is liable to contamination and fermentation; bovine virus dried on ivory or quill points is preferable. It should be remembered that a spurious vaccination which does not produce a vaccine vesicle, while it affords no protection against smallpox, may prevent subsequent vaccination which shall be protective. For this reason it is important to use only virus from reliable sources, and free from contamination or decomposition. In a majority of cases, if the virus be taken at the proper time (eighth day after vaccination) from the arm of a healthy child having no taint of a hereditary or communicable disease, such as scrofula, consumption, syphilis, erysipelas, scarlet fever, etc., and undergoing the action of its first vaccination, and if a properly clean lancet be used, no harm will result to the person vaccinated, and a good vaccination may be secured. This method involves rupturing the ves-

icle on the arm of the child from whom the virus is obtained, and this is objectionable because it may interfere with the complete development of its vaccination. But because harm has sometimes resulted from the use of virus taken from another person, because it is often impossible to tell whether a child has pure blood and is free from every disease, because it is so easy to obtain pure and fresh bovine virus, and because such bovine virus is efficient, it is better in all cases to use only the pure and fresh bovine virus.

Reasons for preferring bovine virus to humanized virus may be given as follows: 1. By the use of the bovine virus there is secured a more perfect or typical development of the vaccine disease, and hence it may fairly be inferred a greater protection against smallpox; 2. With the bovine virus and with a clean lancet, and with clean surroundings, there is no danger of communicating syphilis; 3. The bovine virus is far more effective than the humanized virus in revaccination; and where the humanized virus fails and the bovine virus works, it is probable that there was susceptibility to smallpox, which the humanized virus did not remove, but which has been removed by the bovine virus; 4. Greater care can be taken in the propagation of bovine virus, a greater supply can be always at command, and always, but especially in times of urgent danger from smallpox, people can have a better guarantee that they are vaccinated with genuine and pure vaccine virus.

7. *Where to Obtain Fresh and Pure Bovine Virus.*—Dr. E. L. Griffin, of Fond du Lac, Wis., by a series of inoculations of young heifers, propagates virus of the Belgian stock of cowpox, obtained from Dr. Warlemont, director of the government vaccine establishment of Brussels. This virus, so far as known, never has passed through the human subject. It is stored on ivory-points, each of which holds enough virus to vaccinate one person, and should be used only for one person. Ten points are sent by mail for one dollar; and if used according to the directions of Griffin's circular within five days of the receipt of the package, their efficiency is guaranteed by him. Dr. Henry A. Martin and son, Roxbury Station, Boston, Mass., propagate virus of the Beaugency stock. Dr. Martin claimed the honor of being the first propagator of bovine virus in the United

States. Both Dr. Griffin and Dr. Martin are believed to be reliable propagators of bovine vaccine virus. Virus is for sale by most druggists. The State Board of Health does not supply vaccine virus.

8. Where Should Vaccination be Performed?—In a room or place free from persons suffering from disease, and from dust or vapors which may convey to the scratched surface, germs of any communicable disease; certainly not in or near a room where there is erysipelas, nor in the presence of one who has just come from a person sick with erysipelas, diphtheria, or scarlet fever.

9. By Whom Should One be Vaccinated?—The operation of vaccination should be performed always by a competent and responsible physician, or by some one whom he has instructed and recommends to perform the operation. To try to vaccinate one's self or one's family is poor economy, for it often results not only in a waste of money and of time but in a false and dangerous feeling of security. To trust to vaccination by nurses and midwives is equally foolish. A well-educated and experienced physician has the skill, and the special knowledge necessary to the best judgment on all of the questions involved, without which the operation may be a failure, or worse than a failure. In work of this kind the best is the cheapest, whatever it costs.

10. How to Vaccinate.—In remote places it is sometimes necessary to vaccinate persons who are practically beyond the reach of a competent physician. For the benefit of such, and not as an encouragement to others to dispense with the services of a skillful physician, the following suggestions are made as to the best method of vaccinating. As a rule, the most convenient place for vaccination is found to be on the outer surface of the left arm, about one-half or two-thirds of the way up from the elbow to the shoulder. An infant which its mother carries on her right arm should be vaccinated on its right arm in order to avoid rupturing the vesicle by pressure against its mother. With a sharp pointed and perfectly clean instrument (lancet) make six parallel scratches, barely sufficient to make a show of blood, but not to cause bleeding. Directly across these scratches make four or five similar scratches, so that the scarified place shall be as large as a split pea. . . . If blood flows, wait and wipe it off before applying the lymph. The virus is at and near the pointed end of the ivory carrier. Moisten the lymph upon the ivory point with half a drop of pure water, which has recently been boiled and cooled, smeared over it with the lancet. Then *rub the point over the scarified surface briskly for a minute, so as to lodge the granules in the abraded surface.*

The lymph which may be deposited on the sound skin should be scraped upon the scarified place and allowed to dry there. When the arm is dry, return its ordinary clothing, between which and the arm a loose, soft cloth should be fastened. Do not put on a tight bandage or any plaster. Let no saliva touch the scratched place, neither to affix a plaster nor in any way. Allow no water to touch the place unless it has been recently boiled. When an ivory point has been used, throw it in the fire. Except there is urgent necessity, do not use the same point on two persons, and not then if there is danger of communicating disease. Vaccination sometimes fails because the arm is not well scarified and the virus is not thoroughly rubbed into the scarified surface. A skillful vaccinator can generally use sufficient care to insure success in a susceptible person. Never cut entirely through the skin. Virus should not be inserted under the skin. Except with young children, and with feeble persons, for whom only one place is recommended, two or more places an inch or more apart may be scarified and vaccinated.

11. After Vaccination.— Let the vaccinated place alone. Do not scratch it or otherwise transfer the virus where it is not wanted.

12. Common Appearances after Vaccination. — For a day or two nothing unusual should appear. A few days after that, if it succeeds regularly, the skin will become red, then a pimple will form, and on the pimple a little vesicle or blister which may be plainly seen on the fifth or sixth day. On the eighth day the blister (vesicle) is, or should be, plump, round, translucent, pearly white, with a clearly marked edge and a depression in the center; the skin around it for about half an inch is red and swollen. This vesicle and the red, inflamed *circle* about it (called the areola) are the two points which prove the vaccination to be successful. A rash, and even a vesicular eruption, sometimes comes on the child's body about the eighth day, and lasts about a week; he may be feverish, or may remain quite well. The arm may be red and swollen down as far as the elbow, and in the adult there will usually be a tender or swollen gland in the armpit, and some disturbance of sleep for several nights. The vesicle dries up in a few days more, and a crust forms, which becomes of a brownish mahogany color, and falls off, from the twentieth to the twenty-fifth day. In some cases, the several appearances described above may be delayed a day or two. The crust or scab will leave a well-marked, permanent scar.

13. Signs of Successful Revaccination. — When a person who has been once successfully vaccinated is afterward revaccinated, there sometimes results a vesicle which, as regards its course and that of the attendant areola, cannot be distinguished from the perfect results of a primary vaccination, and this is more likely to occur if bovine virus is used. But often the result is modified by the influence of the previous vaccination, no true vesicle forms, but merely a papular elevation surrounded by an areola; and this result having attained its maximum on or before the fifth day, afterward quickly declines. Or, if a vesicle forms, its shape is apt to vary from that of the regular vesicle, and its course to be more rapid, so that its maturity is reached on or before the sixth day, its areola declines on or before the eighth day, and the scabbing begins correspondingly early. In either case [the areola tends to diffuse itself more widely and less regularly, and with more affection of the areolar tissue than in primary vaccination, while the itching and feverishness may be present much the same as in primary vaccination. When the results of a revaccination are not well marked, protection should not be presumed unless the same virus is proved to be efficient in a primary vaccination.

14. What to Do During and after Vaccination. — Do nothing to irritate the eruption, do not pull the scab off; when it drops off, throw it in the fire. When the eruption is at its hight, show it to the doctor who performed the vaccination. If it is satisfactory, ask him for a certificate stating when and by whom you were vaccinated, whether with bovine or humanized lymph, in how many places, and with what result at each place. When the arm is healed, if the vaccination did not work *well, be vacci-*

nated again as soon as possible, this will be a test of the protection secured by the former vaccination, and will itself afford increased protection. Do not be satisfied with less than four genuine vaccine scars, or with four if it is possible to secure more than four. This vaccination a second or third time in close succession is believed to be hardly less important than vaccination the first time, and hardly less valuable as a protection against smallpox. Without doubt many persons are living in a false sense of security from smallpox, because at some time in their lives they have had a little sore on their arms caused by a supposed or a real vaccination, or because an imperfect vaccination failed to "work," or because they were successfully vaccinated, or had the varioloid, or the unmodified smallpox many years ago. Until smallpox is stamped out throughout the world so that exposure to the disease shall be practically impossible, the only personal safety is in such perfect and frequent vaccination that one need not fear an exposure to smallpox through the recklessness of the foolish. Statistics abundantly prove that among the unvaccinated, smallpox has lost none of the deadly power which made it such a terror to former generations.

15. Make a Record of Your Vaccination. — Do not fail to procure and preserve the certificate mentioned in the preceding paragraph, and also to make a personal record of the facts with regard to any vaccination of yourself or your family. From it you may sometime learn that it is ten years since you or some member of your family was vaccinated, when you thought it only five.

16. Vaccination before Admission to the Schools. — In some places, and with good results, the board of education has made the possession of a certificate signed by some competent physician, stating that the child has been successfully vaccinated within a given number of years or months, a condition to admission to the public schools. Such a regulation seems to be one of the most efficient means of securing a general vaccination of the young people.

17. Corporations and Large Business Firms may well prevent interruption of their business by smallpox, by requiring employees to exhibit certificates of successful vaccination and of revaccination.

18. Do not Delay to be Vaccinated.—By setting about it at once there will be time to secure pure and fresh vaccine virus, and neither sickness nor haste need prevent a successful vaccination. But if one puts it off, he may suddenly be called away on an unexpected journey in which he may incur greater risk of exposure to smallpox; or smallpox may appear in his vicinity, and for want of time to procure reliable vaccine virus, he may be compelled to accept vaccination with virus neither fresh and active nor of known purity; and vaccination with inferior virus, while it affords but little protection against smallpox, may be a hinderance to successful vaccination with the best virus; or by his delay he may contract smallpox itself, with all its dangers, and with an expense many times larger than the cost of thorough vaccination.

19. Smallpox Occurs at all seasons of the year, but as a rule is most prevalent in cold weather. It has been suggested that this may be in part due to a lack of ventilation in winter, by which the poison becomes more concentrated, and to the greater irritation and rawness of the throat and air-passages caused by the cold, dry air and by the more abundant ozone in winter, the sore throat supplying a place where smallpox may easily be inoculated; it is known also that in a warm, moist air vaccine virus decomposes more readily than in a cold, dry air, and the same is probably true of smallpox virus. This greater liability to smallpox in winter makes it important that one should not wait till winter and its dangers have come before being vaccinated, and also that he should not suffer the winter to pass without being vaccinated.

20. Smallpox not Spontaneously Generated.—It is believed that neither smallpox nor any other strictly contagious disease is originated in Michigan, and that smallpox may in great part be kept out of the State if proper measures are taken, such as the systematic inspection of immigrants and travelers and the isolation and disinfection of all infected material.

21. Premises.—Privies, cesspools, water-closets, drains, gutters, and all other such places liable to receive the contagium of a disease, should be frequently and liberally treated with the copperas solution mentioned in paragraph 9, on a page preceding this.

22. Rags.—No person should handle old clothing or rags without taking precautions to prevent the spread of communicable diseases. Children should not be allowed to go near a rag-gatherer's collection, nor into the rag-rooms in paper-mills or storehouses.

DIPHTHERIA CONTRACTED FROM ANIMALS.

BY J. LEWIS SMITH, M. D., NEW YORK (BELLEVUE HOSPITAL).

It is now known that several animals, even those that are pets of the nursery, are liable to be attacked by diphtheria. Indeed this has been proven, as we have seen in the laboratories; for bacteriologists, investigating the nature of diphtheria, have in numberless instances communicated the genuine disease to animals, by inoculating them with cultures of the Klebs-Lœffler bacillus. It is very important that parents should know that milk, the common food of the nursery, is a culture medium of the diphtheritic germ. The specific bacillus falling into the milk in the handling at the farm-house or elsewhere grows and multiplies in it. Mr. Cole, a veterinary surgeon of Australia, published in the Australian *Veterinary Journal*, February, 1882, the history of an epidemic of diphtheria that was traced to the use of milk from a diseased cow. The London *Medical Times and Gazette* for January, 1879, states that Mr. W. H. Power, a health inspector, investigated an outbreak of diphtheria, and obtained sufficient evidence, in his opinion, that it was caused by the use of milk that contained the diphtheritic germs. The cows that furnished the milk had what the veterinary surgeons designate garget, or infectious mammitis. The history of another similar epidemic is related in the same journal.

In the *Deutsche Zeitschrift für Thiermedizin*, 1877, Professor Dammann, of the Hanover Veterinary School, reports an epidemic in calves that was diagnosticated diphtheria. He directed the attendant to make applications to the throats of the sick calves. This was on April 29. On May 5, the attendant became sick, complained of his throat, and was confined to bed. A grayish-white patch of pseudo-membrane appeared upon his tonsils, which were highly inflamed. He had fever and enlargement of both sub-maxillary and cervical glands. The dairymaid, who now took charge of the calves, also had a similar but less severe attack.

The *Occidental Medical Times* for July, 1890, publishes an interesting and instructive paper by Dr. E. Klein, the well-known bacteriologist of London. He states that he inoculated two cows upon the shoulder with the diphtheritic virus. The inoculation was followed by the occurrence of vesicles and pustules upon their udders, and microbes were found in their milk. Two calves were inoculated with the matter taken from the vesicles and pustules, and similar eruptions were produced in them, followed by broncho-pneumonia, and fatty kidneys, such as occurred in the cows. Two cats fed with the milk from the cows, sickened with feline diphtheria, and this was followed by an epidemic among the cats kept for experimental purposes in the laboratory. Fourteen sickened with it, some of them dying. It is evident from the above observations and facts, that the utmost pains should be taken to obtain milk designed for the nursery, from a healthy source, and to prevent its subsequent infection. We may also anticipate our remarks on the prevention of diphtheria by stating that milk designed for the nursery should always be subjected to the prolonged action of heat near the boiling point, which destroys all pathogenic germs. I invariably direct that it be steamed in or over boiling water two hours, as soon as possible after its reception.

Klein has made experiments showing the identity of feline and human diphtheria, though diphtheria in the cat presents some anatomical characters different from those in man, and the following observations appear to show that it is sometimes communicated by this pet of the nursery to the children that fondle it. The *Medical Press and Circular*, June 4, 1890, states that Dr. Lawrence reports two cases under his care in which diphtheria seems to have been communicated by cats. In the first case, that of a little girl, a careful inquiry showed that she had not been exposed to any patient with diphtheria, although this disease was prevailing within a mile of the patient's residence, but that she had nursed a sick cat some days previously. The cat died soon after, and a second cat became sick and was killed.

Further inquiry disclosed the fact that a neighboring farmer had lost seventeen cats, and another farmer fifteen cats from a throat distemper. One of the farmers stated that he had examined the throats of some of the cats, and found them covered with a white membrane. Dr. Bruce Low, in a report to the Local Government Board, states that a little boy at Enfield had fatal diphtheria, and vomited on the first day of his sickness. A cat licked the vomited matter from the floor, and soon after the boy's death it was noticed to be sick, and its sufferings and symptoms so closely resembled those of the dead boy that it was destroyed by its owner. During the first part of its sickness it frequently went to the rear yard, which was frequented by cats, and a few days subsequently the cat of a near neighbor was observed to be sick. The second cat was nursed during its sickness by three little girls, all of whom took diphtheria.*

P. C. Coleman, of Colorado, Texas, states that after a residence of five years at Colorado, he saw the first case of diphtheria. A child of four years, living thirty miles distant in the country, and with no neighbor within six miles, had diphtheria followed by paralysis. The child was far away from any source of human contagion, and had rarely seen other children. The father stated that two kittens had recently died from what seemed to be the same disease, and the child had frequently kissed them. Dr. Coleman does not doubt that the diphtheria was contracted from them.† Dr. George Turner states that a cat fed with the refuse food of some children sick with diphtheria, also suffered severely with what seemed to be the same disease. Dr. A. Jacobi relates the following example: Three kittens were allowed to remain with five children sick with diphtheria. The kittens sickened and died, and a post-mortem examination revealed the presence of the diphtheritic pseudo-membrane in their throats. Cats travel from house to house, often congregate, and are petted by children, so that they are likely to communicate any contagious disease which it is possible for them to contract. It appears from the above observations that they have communicated diphtheria in some instances in which its origin was obscure.

**British Medical Journal*, May 10, 1890.

† *Medical Record*, Nov. 1, 1890.

Observations show that the feathered tribe are especially liable to diphtheria. On the island of Skiathos, off the northeastern coast of Greece, no diphtheria had occurred during at least thirty years previous to 1884, according to Dr. Bild, the medical practitioner of the island. In 1884 a dozen turkeys were introduced from Salonica. Two of them were sick at the time, and died soon afterward. The others became affected soon afterward, and of the whole number, seven died, three recovered, and two were sick at the time of the inquiry. These two had difficult breathing, swelling of the glands of the neck, and a pseudo-membrane extending to the larynx. As further evidence that the disease was diphtheria, one of the turkeys that survived had paralysis of the feet. The turkeys were in a garden upon the north side of the town, and the prevailing winds upon the island are from the north. When this sickness was occurring among the turkeys, an epidemic of diphtheria commenced in the houses in proximity to the garden, and spread through the town. It lasted five months, and of 125 individuals attacked by diphtheria in a population of 4,000, thirty-six died. From this time diphtheria has been established on the island, and frequent epidemics of it have since occurred.*

According to M. Menzies, diphtheria is common among the poultry of Italy, in which country the flat roofs of the houses afford a resting-place for turkeys, fowls, pigeons, and rabbits, whose evacuations are carried by the rains into the cisterns and wells. A physician at Posilippo, near Naples, had directed his servant not to obtain drinking water from the well next to his house, but from a well at a distance. As long as the instruction was obeyed, the family was well; but the indolent servant disobeyed the command, and obtained water from the infected well. Four of the children who drank this water soon contracted diphtheria, and died. The fifth child, who did not drink the water, escaped. Among the writers who have related instances showing the transmission of diphtheria from the feathered tribe to man, may be mentioned Nicatè, of Marseilles,† and Dr. Delthel.‡ In the *American Practitioner and News*, Dr. F. T. Wheeler states that while in a nesting of wild pigeons he found many sick with a pseudo-membranous sore throat. He dissected some of them with his pocket-knife, which he was obliged to throw away on account of its offensive odor. There were millions of pigeons in the nesting, and they were hunted and eaten by the inhabitants, among whom diphtheria broke out, fatal to many of the children. Several years previously there was a similar nesting of pigeons near by, and fully half of the children had diphtheria. In the *Journal of Laryngology and Rhinology*, Dr. George Turner states that a pigeon that had died of the throat distemper was brought to him for dissection, and he found a pseudo-membrane covering the whole windpipe. With this he inoculated other pigeons, and produced in them a similar disease, which extended up the nostrils to their eyes.

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* *Bull. Med.*, Jan. 22, 1888.

† *Marseille Med.*, p. 105, 1879.

‡ *Journal de Méd., de Paris*, Feb. 19, 1888.

Dr. Turner also states that an epidemic of diphtheria broke out in the village of Braughing, Hertfordshire, England, the first cases occurring on a farm where the fowls were dying of a disease similar to that in the pigeon, and on other farms where the children had diphtheria, a similar malady of the fowls prevailed. At Longham a man bought a chicken at a low price, as it was sick with the prevailing disease, and cared for it at home. His children soon sickened with diphtheria, which extended from his family through the village. Dr. Turner mentions similar instances, showing that the feathered tribe, the common barn-yard fowl, turkeys, pigeons, and in one locality pheasants, died of a disease attended by a pseudo-membranous exudation, which was probably diphtheritic.

There is, therefore, sufficient evidence that diphtheria is not only communicated from person to person like other contagious diseases, but that it is often communicated by cases so mild that they go abroad and mingle with other children. It is evident, also, that the specific principle of diphtheria, to wit, the Klebs-Lœffler bacillus, often adheres to objects for months and years, rendering them infectious, that several of the domestic animals are liable to diphtheria, and that there can be little doubt that epidemics of this fatal disease of obscure origin have repeatedly originated from these animals. These facts in reference to the causation of diphtheria, show in what ways this scourge of modern society, conveyed to commerce and travel, has encircled the globe, and how it has become established, or endemic, in all or nearly all the cities in both hemispheres.— *Babyhood, Monthly San. Record.*

WATER SANITATION.

BY E. H. BARTLEY, M. D.,

Professor of Chemistry and Toxicology, and Lecturer on Diseases of Children,
Long Island College Hospital.

THE question of the value of filters for the purification of drinking water has been examined by Bertschinger,* who found that sand filtration removed nearly if not quite all the germs from the water of Lake Zurich, yet, some time after filtration, the water contained a few organisms. Fraenkel and Piefke † found that at the beginning and after long use, bacteria pass through sand filters, and that the number which pass depends largely upon the rapidity of the filtration. They found that during an epidemic of typhoid fever in Berlin in 1889, the people who suffered most, used the water filtered through sand; and it was suspected that the condition of the filter at the time might have aggravated the outbreak. Experiments made with water containing the organisms of typhoid and cholera, showed that both of these organisms passed through the filter in numbers proportional to the rapidity of the filtration.

After the filter has become fouled by use, the number of organisms in the filtered water is more than in the unfiltered.

Austin Devonshire ‡ describes the process used in Antwerp, consisting of a layer of powdered or spongy iron, made by heating hematite ore. William Anderson has devised an apparatus by which the powdered iron is revolved in a cylinder as the water is made to flow through the latter, by which means it is claimed there is a thorough purifying of the water before it is passed through the sand filters. This process is being developed in Chicago for the purification of drinking water, and it is claimed that it is the best form of filtration now known. It does not become foul by use, as do sand and charcoal filters.

Alterhoefer § finds that the addition of peroxide of hydrogen, in the proportion of 1 to 1,000, to water containing typhoid or cholera bacilli, is sufficient to destroy these organisms, if the peroxide be fresh and in good condition, and is allowed to act for twenty-four hours.

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* *Gazette med. de Nantes*, July, 1890.

† *Zeitschr. f. Hygiene*, 1890.

‡ *Sanitary News*, June, 1890.

§ *Centralblatt f. Bakteriol.*, July 25, 1890.

Chancellor* thinks that all manufacturers and tradespeople should be compelled to purify their waste waters before discharging them into public waters. He quotes Jennet's experiments to prove that alum added to natural waters, in the proportion of 2.3 grains per gallon of water, renders it drinkable, even when full of organic matter.

Profs. Austin and Leeds have shown that a much less quantity is sufficient. Leeds found that waters rich in organic matter, peaty water, which had been treated with alum and then filtered, were sterilized by this process. No alum is left in solution unless an excess is used.

The effect of freezing upon the purity of water has been investigated by the Massachusetts Board of Health.† In ice from polluted waters, the experiments showed that freezing removes a large part of the color and the salt, and that all but thirteen per cent of the other impurities were removed.

The organic impurities of all ice examined, except snow ice, equals twelve per cent of the impurities of the water from which it was formed. The organic impurities in clear ice are six per cent of those in the water. The bacteria in ice from polluted waters are greatly diminished. The average number of bacteria in a cubic centimeter of twelve samples of ice from the most polluted sources, was one hundred and thirty-eight.

The Board warns the public against the use of ice, for domestic purposes, that is obtained from a source polluted by sewage beyond that allowable in drinking water; and in general, it is much safer to use for drinking water that portion of ice that is clear and transparent.

Charles G. Courrier states,‡ as the result of his experiments, that the charging of water with carbonic acid gas does not render polluted waters safe to use. He observed that certain kinds of bacteria increase to a certain degree in waters charged with carbonic acid, under a pressure of one hundred pounds to the square inch.

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* *Sanitary News*, Sept. 4, 1890.

† *Sanitary News*, August 30, 1890.

‡ *Med. Record*, June 14, 1890.

The author says that a temperature of 158° F. maintained for fifteen to thirty minutes will destroy the organisms of malaria, cholera, typhoid fever, diphtheria, or the suppurative processes. Merely raising water to the boiling point and then allowing it to cool, makes it safe for drinking purposes, but does not completely sterilize it, the organisms remaining, being harmless. To destroy all the micro-organisms, it is necessary to keep the water at the boiling point for one hour. It may then be used to irrigate wounds with safety or to prepare alkaloidal solutions, which will keep indefinitely, provided it is not contaminated subsequent to the treatment.—*The Brooklyn Medical Journal.*

THE MICROBES OF OSTEOMYELITIS.

As might have been expected, considerable prominence was given in the recent discussions of the French Surgical Congress to the microbian origin of diseases which come under the surgeon's observation. One of the most important contributions to our knowledge of the etiology of diseases, the causes of which have until recent times been involved in mystery, was made by Professor Lannelongue in connection with acute osteomyelitis. Having investigated bacteriologically thirty-seven cases of this disease that have come under his notice during the last two years and a half, he found that the micro-organisms that excited the morbid process could be thus classified: Staphylococcus aureus, twenty-one cases; staphylococcus albus, seven cases; both the preceding concurrently, one case; streptococcus, four cases; pneumococcus, two cases; Eberth's bacillus, two cases. The microscopical results were controlled in each instance by the reproduction by inoculation of the pure cultures of the same form of the disease in the lower animals. The following points of distinction were established between streptococcic and pneumococcic osteomyelitis: In the streptococcic form, arthritis and erysipelas were common. There is a sudden elevation of temperature, a fall in the course of two or three days, rapid supervention of suppuration, the pus being almost serous in consistence. The skin soon assumes a red appearance, due to angeioleucitis. This variety occurs chiefly in very young children, whose mothers have suffered from puerperal complications — in other words, streptococcic infection. In the two cases of pneumococcic osteomyelitis, the point of entrance of the micro-organism was not discovered; it is therefore probable that the infection occurred through the medium of the general circulation. In this form the joints are the seat of profuse suppuration, but they soon recover. In conclusion, Professor Lannelongue states that of these different varieties of the affection, that due to the staphylococcus is the most serious, the pneumococcic form is the least dangerous, while that occasioned by the streptococcus takes an intermediate place.— *Lancet.*

ACQUIRED IMMUNITY.

THIS subject, which is one that furnishes one of the most interesting problems for the investigator, has in one of its phases, undergone a fairly thorough investigation by Messrs. Emmerich and O. Mastbaum. The special point to which the attention of the gentlemen was directed was the cause of the immunity from infective disease that sometimes exists naturally, and that can be produced by preventive inoculation, and that of the retrogression of an infective disease when it has once been set up. The disease specially studied was swine fever, and the reasons for this selection were (1) because the fever bacillus is undoubtedly the cause of the disease, (2) because animals easily procurable — mice and rabbits — are readily susceptible to the poison of the disease, and (3) because it has been determined by Pasteur and others, that swine as well as rabbits can be protected against the disease by protective inoculation.

The authors claim that they have proved the truth of a theory of others, to the effect that the cause of artificial immunity lies in an anti-bacterial toxine, which is, however, non-injurious to the organisms; that the toxine is produced by the irritation which the invasion of the bacteria causes in the cells, or which is a combination formed by the mutual interaction of the peculiarly modified decomposition products, and the tissue changes of the bacteria themselves.

For the experiment the tissue fluid withdrawn in a special manner from the protected animals was employed. The curative action of the fluid could not be doubted. In the case of white mice and rabbits, every trace of the fever could, without exception, be cured with certainty, provided that the bacilli of the disease had not entered and disseminated themselves through the system more than twenty-four hours previous to the inoculation. The fact that the curative fluid exerted its influence even when the animal injected was of a different kind to that yielding the fluid — thus, fluid from protected rabbits, rendered white mice proof against disease — justified the hope that fluid from protected rabbits would be successfully employed to cure infected swine. The great advantage of this kind of protection over that hitherto practiced would be its complete harmlessness to the animal treated by it, and in fact its harmlessness as regards all animals. When the disease first breaks out among the swine of a farm, all the animals are at once inoculated with fluid from an artificially protected rabbit, and the outbreak is at an end. The curative inoculation sets up no serious symptoms, and nutrition is not interfered with.

The authors claim that they have by these experiments entered upon the first stage of a certain and rational treatment of infectious diseases, and urge that it is the duty of all to strive for the attainment of an ideal treatment, which consists in the discovery and manufacture of the true anti-bacterial material. The time is perhaps not far distant when such a material will be in the hands of all who are called on to treat infectious diseases. Other diseases besides swine fever are already under investigation. Dr. Fawitzky is making a study of croupous pneumonia, Dr. Gabritzchewsky, of the anthrax, and the authors have taken up the subject of tuberculosis. It will be observed that the difference between the treatment introduced by Koch and that by the authors is, that the fluid used by Koch was procured from pure cultivations of the tubercle bacillus itself, while that used by Messers. Emmerich and Mastbaum comes from the protected animals themselves.— *Berlin Correspondence in Medical Press and Circular.*

PASSAGE OF THE BACILLUS OF TUBERCULOSIS FROM THE MOTHER TO THE FŒTUS.

Birch-Hirchfeld and Schmorl* have put on record a case which they claim is the first in which it has been definitively proved that in the human subject tubercle bacilli pass from the mother to the fœtus. The patient was a young woman who, shortly after the commencement of her first pregnancy, began to show signs of phthisis; these gradually became more marked, and she succumbed at the seventh month of her pregnancy. Immediately after the death of the mother the fœtus was removed by Cæsarean section. The necropsy on the mother showed abundant evidence of phthisis; not only in the lungs, but in other organs, tuberculosis was detected. Although the fœtus had been alive shortly before the death of the mother, it was dead when it was removed. The chest was at once opened, but there was nothing noteworthy about the lungs. The fœtus was then taken to the laboratory, the surface of the abdomen was washed with perchloride of mercury, and the cavity was opened with sterilized knives. No tubercles could be seen on any of the organs. Minute pieces of the liver, the spleen, and the kidney were placed in the abdominal cavity of two guinea-pigs and a rabbit, with all antiseptic precautions. One of the guinea-pigs died in fourteen days, and tubercles were found in different parts of the abdominal cavity. The second one was killed about six weeks after inoculation, as it was clearly ill, and many tubercles were found in the peritoneal cavity. The rabbit lived three months; on its death many tubercles were found in the liver and the lung. Tubercle bacilli were found in the umbilical cord and the blood of the umbilical vein.—*Brit. Med. Jour.*—*Med. and Surg. Reports.*

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* "Beiträge zur Path. Anat. und zur Allg. Path.," 1891, p. 429.

CONDITIONS WHICH MODIFY THE VIRULENCE OF TUBERCLE BACILLI.

Ransome* details a few experiments, which, so far as they go, lend weight to the assertion that light, pure air, and porous soil cause tubercle bacilli to become less virulent. He selected two specimens of sputa which contained tubercle bacilli, and exposed them in the following ways: The first specimen was over a dry soil, exposed freely to light and pure air; the second was placed in a dark room in the same neighborhood; the third specimen was placed in a small tenement house in Manchester, and exposed to all the light that could be secured on the window-sill; a fourth specimen was exposed in a dark room in the same tenement; a fifth specimen was exposed in the ventilating shaft of the consumptive hospital. Animals were then inoculated with the sputum after it had been exposed five weeks. None of the specimens exposed to fresh air and light conveyed the disease. One of the specimens exposed in the same place, but in darkness, produced the disease. Of two specimens exposed in the tenement in the night, one produced the disease and one did not. Of two specimens exposed in the dark room of the tenement, one caused the disease and one did not. The specimen from the shaft of consumptive hospital produced the disease.— *Med. Progress.*

EXPERIMENTAL STUDY OF KOCH'S TUBERCULIN.

At the Congress for the Study of Tuberculosis, at Paris, July 29, 1891, M. Arloing, of Lyon, stated that he had made extensive experiments with Koch's tuberculin on animals. He had successively examined the diagnostic, therapeutic, and prophylactic values which have been attributed to this substance.

Concerning diagnosis, the experiments made in M. Arloing's laboratory have demonstrated that the reaction produced by Koch's tuberculin is not peculiar to tuberculosis. It has, therefore, no diagnostic value in tuberculosis.

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* *British Medical Journal*, April 14, 1890.

As to its therapeutic power, the results of these experiments show that in no case has tuberculin arrested the progress of experimental tuberculosis. It has often, however, hastened and precipitated the end by the intense congestion which it produces.

Finally, as a prophylactic, in animals previously inoculated with Koch's tuberculin, experimental tuberculosis has developed as usual, sometimes even more rapidly than in the animals which were not inoculated.— *Gazette des Hôpitaux, July 30, 1891, p. 816.*

EDITORIAL.

Reviews, Analyses, Digests, Etc.

We announced in our last issue, the removal of the Bacteriological World to Battle Creek, Mich. To-day we have the pleasure of informing our readers that after this month we shall publish under the name of Bacteriological World and Modern Medicine. The study of bacteriology will be, as ever, the chief scientific feature of the magazine, and we will give as much material as before, only more condensed, more concise, more original, and better in every way, and will increase the quantity of total pages to eighty or ninety. We are perfecting arrangements with foreign and home investigators of the foremost scientific laboratories, to the end that we may present our subscribers the most accurate researches and the most reliable results obtainable in the department of science in which we are engaged. Already we have the name of the famous Italian scientific physician Apostoli, among our contributors, and an important original article will appear in the next number from his pen. It is entitled, "The Influence of Continued Electric Current on Bacteria."

The addition of a department on Modern Medicine, in charge of Dr. J. H. Kellogg, who ranks high among those who best represent advanced thought in medical science, is an advance step, and an acquisition which every one will surely appreciate. Modern medicine is largely based on the science of bacteriology, consequently it is fitting that a journal voicing the thoughts of scientific men in this practical field, be established in connection with a periodical of the kind of ours. The combination will be the only magazine published in the English language on the special subject of which each department shall treat.

I leave to Dr. Kellogg, editor of the department on Modern Medicine, to explain his views on the subject in next number. I will only add that we shall hereafter issue a larger and better magazine for only two dollars, charging at the rate of three dollars for back numbers. We hope that our efforts to reach every one interested in bacteriology, and the modern improvements in the medical sciences, will be appreciated and encouraged.

P. P.

TECHNIQUE.

THE BLOOD PLAQUE.

In the October number of the *American Monthly Microscopical Journal* there is an article of great scientific interest, by Dr. George T. Kemp, of the University of Pennsylvania. It was abridged from the original article in the "Studies from the Biological Laboratory, Johns Hopkins University." We can only make a very brief extract, as follows :—

If a drop of one per cent osmic acid be placed on the finger, and the finger pricked with a needle through the drop, the elements of the blood will all be hardened and preserved in their natural appearance.

If a thin film of this blood be examined with a good lens (magnifying six hundred to eight hundred diameters), the plaques may be seen floating in the plasma among the red corpuscles and leucocytes.

They are pale, homogeneous, variable in size, about one third to one fourth the diameter of a red corpuscle. Seen on surface, they are circular or elliptical, and seem at first sight flat, but are very slightly biconcave, as shown when seen edgewise.

The form of the plaque when thus studied never undergoes change. This is not the case in blood drawn and allowed to clot. To study this the following method is adopted : The finger is pricked and a good-sized drop of blood squeezed out and taken immediately upon a cover-slip ; then as quickly as possible, most of it is washed off by a jet of seventy-five per cent Na Cl solution from a wash-bottle. The slip is now examined under the microscope. The plaques have the property of sticking to the slip, while the other elements are washed away by the jet, so that on examination the whole field is found filled with plaques, mostly grouped in masses of two to twelve or more.

They are no longer pale and homogeneous, with symmetrical outline, but appear glistening and granular, and their contour has become jagged. These changes are more marked the longer the time which has elapsed before the preparation is observed, and they may be seen to take place step by step while a preparation is being watched. This change progresses until only a granular mass remains, the individual plaques being no longer distinguishable. *Pari passu* with these changes, processes may be seen to run out from the granular masses, and when coagulation sets in, these are usually found continuous with the threads of fibrin.

The threads of fibrin are sometimes deposited as long, needle-shaped crystalloids, which are often seen lying in the field free from any granular masses, but the greatest number are formed most thickly around those masses, from which they often radiate. . . .

Dr. Kemp's conclusions, briefly stated, then, are :—

1. The blood contains a third histological element, the *plaques.*
2. No evidence that this is *genetically* related to either the white or the red corpuscle.
3. Plaques break down at once when the blood is drawn ; other elements do not.
4. Their breaking down intimately connected, in time, at least, with clotting of the blood.
5. The connection between the plaque and the clot not a histological, but a chemical one.
6. The active agent is most probably fibrin-ferment.
7. Fibrin is deposited histologically independent of any cellular elements of the blood.
8. When the clot is scant, fibrin is deposited as thin, needle-shaped crystals.

IMBEDDING FOR SECTION-CUTTING.

From an article in the *American Monthly Microscopical Journal,* by Dr. J. W. Blackburn, of the Government Hospital for the Insane, at Washington, we make the following extracts :—

For success in the paraffine method it is essential that the following points be remembered :—

1. The tissues must be thoroughly *dehydrated.*
2. An intermediate bath of paraffine in the solvent must be used to prevent shrinkage.

3. The solvent must be *completely* replaced by pure paraffine.

4. Dry heat should be used in all the melting processes.

5. Paraffine with a proper melting point must be used, as it is not safe to heat to, or beyond, 60° C. (140° F.); nevertheless, tissue will not be injured by any temperature which can be borne by the hand.

6. The section knife must be perfectly free from breaks in its edge, and *very* sharp.

MYRTLE WAX IMBEDDING PROCESS.

In an article in the *New York Medical Record*, April, 1885, Dr. Maurice N. Miller, of New York, called attention to a new imbedding material which he claims possesses some advantages over the paraffine and celloidin processes. The material is myrtle wax or bayberry tallow. Myrtle wax is a substance derived from *Myrica cerifera*, a shrub from one to twelve feet high, growing in the United States, especially along the eastern coast.

The wax is found covering the fruit as a whitish coat, and is separated for use by boiling the berries in water; the wax separates and rises to the top, and is either skimmed off or allowed to concrete as the liquor cools, and is then removed. It is of a pale, grayish-green color, somewhat diaphanous, brittle, slightly unctuous to the touch, and has a feeble aromatic odor and a slightly bitterish taste. Its sp. gr. is about that of water, and its melting point is about 46.6° C. to 48.8° C. (116° F. to 120° F.) . . . .

The wax described above is no doubt the true product of *Myrica cerifera*, but for the purposes of the microtomist it will *not* answer. A variety must be obtained which is *yellowish white* in color, tougher and softer. This variety, though *sold* as myrtle wax, is probably the product of *Rhus succedanea, L.*, and should be called "Japan wax."* With the above exceptions, the same description of physical characteristics will answer for both. . . .

The method of using myrtle wax is as follows: The specimens are dehydrated in absolute alcohol, and then placed in a solution of wax in chloroform, as a preliminary bath, or transferred directly to the melted wax. The pieces will be infiltrated in about the same time required by the paraffine method.

The pieces may be fastened on cork, by using the melted wax, or imbedded in blocks of wax or paraffine, to support the specimen in the clamp of the microtome.

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*Dr. Z. D. Gilman, of Washington, D. C., informs me that the wax in question is imported through a Japan trading company, and is said to be derived from the *Rhus succedanea*, Ln. If this be its source, it is then one of the varieties of *Japan wax.*

The sections are cut dry, into benzole, washed in alcohol, stained, and mounted as usual.

To completely remove the wax it is best to take the sections through a second bath of benzole, as any remaining wax will be precipitated by the alcohol used in the washing.

Warm, absolute alcohol may be used to free the sections from wax, but the benzole is better and cheaper. . . .

The method is more rapid than either the paraffine or celloidin process, there is very little if any shrinkage, it does not injure the most delicate tissues, and it is inexpensive. . . .

If hardened in large masses, there is a *slight* shrinkage and a tendency to crack; this, I think, may be prevented by the addition of a small amount of paraffine with which it is miscible in all proportions.

I never have seen a section injured by cracking.

NOTICES.

RESTRICTION AND PREVENTION OF MEASLES.

DOCUMENT ISSUED BY THE MICHIGAN STATE BOARD OF HEALTH.

Revised Edition, September, 1891.

1. *Measles is a dangerous, contagious disease,* hence it is a "disease dangerous to the public health," under the laws in Michigan, and the observance of the following precautions is of importance.

2. Inasmuch as measles is spread by those sick with it before the eruption appears, in order that its restriction shall be most complete, it is important that the early symptoms be generally known. In the early stage of measles there is, frequently, sneezing, and a troublesome cough. When a child or a young person has symptoms of measles, or a sore throat, bad odor to its breath, and especially if it has fever, it should immediately be separated from all other persons, except necessary attendants, until it be ascertained whether or not it has measles, or some other communicable disease.

3. *Period of Incubation.*—The interval between the date of infection and that of the outbreak of symptoms of measles, usually varies between seven and twenty-one days. Very rarely the period may be shorter or longer.

4. *Every person* known to be *sick with measles* should be *promptly* and *thoroughly isolated* from the public; no more persons than are actu-

ally necessary should have charge of or visit the patient, and they should be restricted in their intercourse with other persons.

5. *Plain and distinct notices should be placed upon the premises or house in which there is a person sick with measles.*

6. *Householders and physicians* must immediately give notice of the first case and of every case of measles, to the health officer or to the president or clerk of the local Board of Health. This is required by law.*

[7. This section concerning Michigan sanitary laws is omitted.— ED.]

THE RESTRICTION OF MEASLES.

8. The room in which one sick with measles is to be placed, should *previously* be cleared of all needless clothing, carpets, drapery, and other materials likely to harbor the poison of the disease. This room should constantly receive a liberal supply of fresh air, without currents or drafts directly upon the patient.

9. The discharges from the throat, nose, and mouth are liable to communicate the disease, and should be received in vessels containing a strong disinfectant, or on soft rags or pieces of cloth, which should immediately be burned.

10. The discharges from the kidneys and bowels should be passed into vessels containing a strong solution of chlorinated lime, and then be *buried* at least 100 feet distant from any well; the discharges to be disinfected by thoroughly mixing with each discharge not less than one ounce of chlorinated lime. When this is impracticable, they may be passed on old cloths, which should immediately be burned.

11. The clothing, towels, bed-linen, etc., on removal from the patient, should at once, before removal from the room, be placed in a pail or tub of boiling-hot zinc-solution, made in proportion as follows: water, one gallon; sulphate of zinc, four ounces; common salt, two ounces.

12. Nurses' and attendants' hands should be washed and disinfected by chlorinated soda, their hair (and beard) should receive attention, and their clothing should be disinfected, before they appear in public.

13. Every person recovering from measles should be considered dangerous; therefore such a person should not be permitted to associate with others, or to attend school, church, or any public assembly until in the judgment of a careful and intelligent health officer he can do so without

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* Supervisors must prosecute for all forfeitures under it; township officers must give notice to supervisors: prosecuting attorney to conduct suit if requested,— Sections 8439, 8440, and 8442, Howell's Annotated Statutes. Health officers of villages and cities must notify prosecuting attorney of all violations of this law,— §1684, Howell's Statutes; the prosecuting attorney must prosecute for all such forfeitures incurred within his county,— §8442, Howell's Statutes.

endangering others ; nor until after all his clothing has been thoroughly disinfected. Nor should a person from premises in which there is or has been a case of measles, attend any school, Sunday-school, church, or public assembly, or be permitted by the health authorities or by the school board to do so, until after disinfection of such premises and of the clothing worn by such person, if it shall have been exposed to the contagion of the disease.

14. No public funeral should be held at a house in which there is a case of measles, nor in which a death from measles has recently occurred. No child should attend, and it would be better in most cases for few adults to attend, a funeral of a person dead of measles.

DISINFECTION OF ROOMS, CLOTHING, ETC.

15. After a death or recovery from measles, the room in which there has been a case, whether fatal or not, should, with all its contents, be thoroughly disinfected by exposure for several hours to strong fumes of burning sulphur, and then it should for several hours or days be exposed to currents of fresh air.

Rooms to be disinfected must be vacated. Heavy clothing, blankets, bedding, and other articles which cannot be treated with the zinc solution, should be spread out so as to be thoroughly exposed during fumigation, which should take place in the room where the clothing, etc., has been used in connection with the patient. For a room about ten feet square, at least three pounds of sulphur should be used ; for larger rooms, proportionately increased quantities, at the rate of three pounds for each 1,000 cubic feet of air-space.

Close all openings to the room, place the sulphur in an iron pan supported upon bricks, set it on fire by hot coals or with the aid of a spoonful of alcohol lighted by a match. Be careful not to breathe the fumes of the burning sulphur. When certain the sulphur is burning well, leave the room, close the door, and keep the room closed for several hours.

Care should be taken to secure the complete burning of as much of the sulphur as is possible. To avoid danger from fire, the iron pot or pan in which the sulphur is burned should be free from any leak, and it may be placed over water in a tub or pan.

Cotton, linen, flannels, blankets, etc., should be treated with the boiling-hot zinc-solution, introducing them piece by piece, securing thorough wetting and boiling for at least half an hour. Heavy woolen clothing, silks, furs, stuffed bedcovers, beds, and other articles which cannot be treated with the zinc-solution, should be hung in the room during fumigation, pockets being turned inside out and the whole garment being thoroughly exposed. Afterward they should be hung in the open air, beaten, and shaken. Carpets are best fumigated on the floor, but should afterward be removed to the open air and thoroughly beaten.

In no case should the thorough disinfection of clothing, bedding, etc., be omitted.

16. *Hospitals for Persons Sick with Measles.*—Disinfection of a room always necessitates vacating it, and sometimes makes it impossible to remain in adjoining rooms; therefore in some cases it seems essential to have hospital, tent, or other temporary shelter for the inmates of infected houses, where bathing, disinfection, and washing can be done while such houses are being disinfected and put in order. As a means of preventing the spread of disease, the law* authorizes the inhabitants of townships, cities, and villages to be constantly provided with hospitals for the reception of persons having any disease dangerous to the public health, and such is measles. The law† requires local boards of health, on the outbreak of any such disease, to provide such hospitals or places of reception for the sick and infected as they shall judge best for their accommodation and the safety of the inhabitants, and to cause such sick or infected persons, if their condition will admit, to be removed to such hospitals or places of reception. Said hospitals, and (in case the sick cannot be removed to the hospital without danger to life or health) the houses where the sick may remain, and all persons connected with said hospitals, or abodes of the sick constituting temporary hospitals, to be subject to the regulations of the Board of Health, or of a committee appointed by the Board of Health for that purpose.‡

HOW TO AVOID AND PREVENT MEASLES.

17. Avoid the special contagium of the disease. Do not let a child go near a case of measles; this is especially important to be observed by guardians of children between one and two years of age. Do not permit any person or thing, or a dog, cat, or other animal, to come direct from a case of measles to a child. Unless your services are needed, keep away from the disease yourself. If you do visit a case, bathe yourself and change and disinfect your clothing before you go where there is a child.

18. Do not permit a child to ride in a hack or other closed carriage in which has been a person sick with measles, unless the carriage has since been thoroughly disinfected with fumes of burning sulphur, as specified in paragraph 15.

19. Do not permit a child to wear or handle clothing worn by a person during sickness or convalescence from measles.

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* Sections 1667, 1668, 1670, 1671, and 1674, Howell's Statutes.

† Section 1671, Howell's Statutes.

‡ By amended Section 1740 of the Compiled Laws of 1871 (§ 1681 Howell's Statutes), the sections of law relative to townships (Secs. 35–42, of Chapter XLVI of the Compiled Laws of 1871) are made to apply to cities and villages.

20. Beware of any person who has a cough or a sore throat ; do not permit a child to kiss or take the breath of such a person, nor to drink from the same cup, blow the same whistle, or put his pencil or pen in its mouth.

THE AGE AT WHICH MOST DEATHS FROM MEASLES OCCUR.

21. According to the mortality statistics of Michigan for the seventeen years from 1871 to 1888 inclusive, excluding 1885, which was an exceptional year, a little over 71 per cent of all the deaths from measles were of children under five years of age. Only about 8.1 per cent of all the deaths in those years were of persons of ages from ten to twenty years.

While the evidence seems to prove that to persons between the ages of ten and twenty years, the risk of death from measles is slight, even that risk need not be taken if the disease shall be completely restricted.

In the present state of our knowledge, it seems important to restrict measles as completely as possible, and especially so that it shall not reach children in the second year of life.

IMPORTANCE OF RESTRICTING MEASLES.

Quain's Dictionary states : "The annual mortality from measles in London is nearly five per ten thousand."

In England and Wales, in 1889, the deaths from measles (14,732) were five per ten thousand inhabitants, and exceeded those from both scarlet fever (6,698) and diphtheria (5,368).

In Michigan, the *reported* deaths from measles are several times as many as from smallpox ; for the eighteen years, 1871–1888, they averaged 157 per year. If we assume that only three fourths of the deaths were reported, the deaths in Michigan from measles have been about two hundred per year. If the inhabitants of Michigan now number two million, and the mortality from measles were to equal that in London, or that in all England and Wales in 1889, the deaths from that disease in Michigan would equal nearly one thousand per year.

According to Dr. Farr's law, — of increase of contagious diseases as density of population increases, — the death-rate from measles, unless restrictive measures are taken, will undoubtedly rapidly increase in Michigan, with the rapidly increasing population, and especially with the rapidly increasing lines of railroads and other facilities for easy, frequent, and rapid movements of the people. The present very considerable mortality from measles, and also the much greater mortality which may be expected, supply urgent reasons why the measures herein recommended should be generally and thoroughly adopted and enforced.

This document is published by the State Board of Health, for gratuitous distribution throughout the State. A copy may be obtained by applying to the SECRETARY OF THE STATE BOARD OF HEALTH, LANSING, MICHIGAN.

The State Board of Health recommends that local boards of health procure and distribute copies of this document within their jurisdictions, when measles is near, and especially to the neighbors of families in which this disease is present.

INCOMPATIBLES OF ANTIKAMNIA.

THE following substances produce precipitates when added to solutions of Antikamnia: —

Carbolic acid in saturated solution, tannin, mercuric chloride, infusion catechu, infusion cinchona bark, infusion rose leaves, infusion uva ursi, solution extract cinchona bark, tincture catechu, tincture cinchona, tincture hamamelis, tincture iodine, tincture kino, tincture rhubarb.

The following substances produce coloration when added to solutions of Antikamnia: —

Hydrocyanic acid, dilute solution, yellow; nitric acid, dilute solution, weak yellow; ammonia alum, dilute solution, dark yellow; amyl nitrite, acid solution, green; nitrous ether, alcoholic solution, green; copper sulphate, green; ferrous sulphate, yellow-brown; ferric sulphate, blood-red; ferric chloride, blood-red; syrup iodide iron, red-brown.— *Notes on New Pharmaceutical Products.*

"PERSONAL OPINION."

INDIANAPOLIS, IND., August 26, 1891.

I have made several important tests of the therapeutic value of Antikamnia, and have also made it a point to learn the personal opinion of a number of other physicians as to its merits as an "opposed to pain," and now, after six months' investigation, I am pleased to say, without solicitation, that Antikamnia is a therapeutical agent of superior merits.

Respectfully yours,
G. W. PICKERILL, M. D.

THE U. S. VETERINARY MEDICAL ASSOCIATION.

Dr. T. J. Turner, State Veterinarian of Missouri, reports a very interesting and useful meeting of this Association at Washington on Sept. 15. Several most important sanitary subjects were discussed by the members, among whom are many men of public interest, who devote their time and energies to the improvement of humanity, in combating the maladies of lower animals. The knowledge of the diseases of animals is one of the necessary things among the qualifications of a sanitarian, and too much cannot be done to advance the sciences underlying veterinary medicine and surgery in all its departments.

The Association was honored by the presence of the Hon. Jerry Rusk, Com. of Agriculture, who is an enthusiastic supporter of sanitary legislation concerning the diseases of live stock. This is as it should be, and the sooner the medical profession recognizes the very close connection of the diseases of man and beast, the better for the welfare of the nation.

Dr. Rush, Shippen Huidekaper, New York, is President of the Association.

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PREVENTIVE MEDICINE—INDIVIDUAL PROPHYLAXIS.

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Destroys promptly all odors emanating from diseased gums and teeth, and will be found of great value when taken internally, in teaspoonful doses, to control the fermentative eructations of dyspepsia, and to disinfect the mouth, throat, and stomach. It is a perfect tooth and mouth wash, *indispensable for the dental toilet.*

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LITERATURE.

THE POPULAR SCIENCE MONTHLY for October, contains the following articles: "Lessons from the Census," by Carroll D. Wright, A. M.; "The Development of American Industries since Columbus" and "The Manufacture of Steel," by William F. Durfee (illus.); "Metamorphoses in Education," by Prof. A. E. Dolbear; "The Rivalry of the Higher Senses," by G. T. W. Patrick, Ph. D.; "Exercise for Elderly People," by Fernand Lagrange, M. D.; "Life on an Ostrich Farm" (illus.); "Dress and Adornment" and "Dress," by Prof. F. Starr (illus.); "On Polyandry," by Lieutenant-Colonel A. B. Ellis; etc.

LIPPINCOTT'S MONTHY MAGAZINE for ,October presenst its usual list of interesting articles: "Lady Patty," by The Duchess; "Healthy Heroines," by Julian Gordon; "A Tiffin with a Taotai," by Edward Bedloe; "October," by Florence Earle Coates; "The Bells of San Gabriel," by Gertrude Franklin Atherton; "A Minor Chord," by Ella Wheeler Wilcox; "Dream and Deed," by Katharine Lee Bates; etc.

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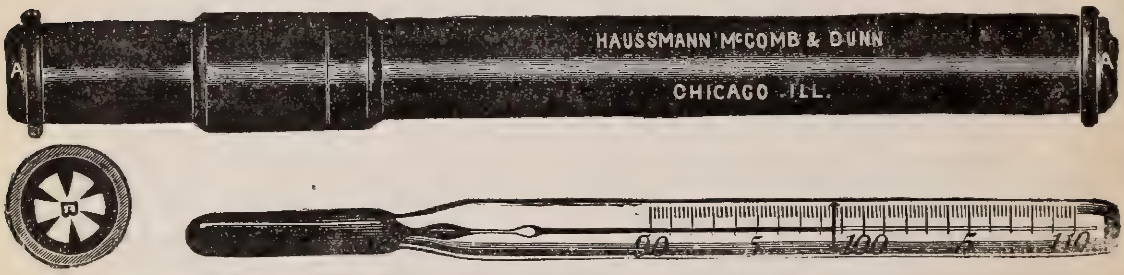

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